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ABSTRACT

A special issue of the journal "On Line" is devoted to reporting the 1974 Instructional Computing in Michigan conference. The conference was divided into numerous sessions, and there are individual reports summarizing the activities and papers of each session. The sessions reported are on the instructional computing aspects of mathematics, physical and environmental sciences, behavioral and social sciences, arts and music, community colleges, college teaching and learning activities, terminals and communication facilities, and the MERIT Computer Network. In addition, a few of the papers presented at the mathematics and sciences sessions are reprinted in this issue. (WH)

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Volume 3 Number 4 *July 1974*

NEWS ON EDUCATIONAL USE OF COMPUTERS AMONG MICHIGAN COLLEGES AND UNIVERSITIES

ON·LINE

Special Summer Issue on ICM 74

SPECIAL REPORTS

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ICM 74 Conference Record

Instructional Computing in Michigan, 1974:
A Working Conference on New Resources for College Teaching

Held March 22-23, 1974, at Michigan State University
in conjunction with the 78th Annual Meeting of the
Michigan Academy of Science, Arts and Letters

Stephanie L. Spencer and Karl L. Zinn, Editors

Prepared and distributed by Project EXTEND
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Introduction to the ICM 74 Conference Record

Karl Zinn, University of Michigan.

In spite of contrary weather on the second and third days of spring, the 1974 Conference on Instructional Computing in Michigan (ICM) appears by all measures to have been successful. One may look at the program or contents of this proceedings, the numbers attending various sessions (summary below), or the remarks of attendees to be assured of the usefulness of these sessions.

The opening workshops were well attended, far beyond expectations. On another such occasion provision should be made for more capacity in the introductory workshops; apparently individuals wish to come early and gain all they can by way of overview and practical working activity. Five simultaneous sessions (as originally intended) could have been filled by the 75 or 80 people who crowded into two.

The session on contributions of computing to learning and teaching was attended by about 45 people. A collection of reference materials and examples was discussed. Questions and comments resulted in a set of dialogues on effective computer use and implications for education and society. The resource materials are available from the workshop organizer, Karl Zinn, at the Project EXTEND office in Ann Arbor.

The workshop on terminals and communications was attended by about 30 persons. The chairman, LeRoy Botten, provided a draft of a paper on planning communications for time sharing and remote access. This may become a useful companion piece for the paper on planning main frame computer selection which the same author prepared in connection with the ICM conference last year. Both are available from him at Andrews University in Berrien Springs.

The workshops adjourned to the demonstration and display areas. Five or six examples of instructional computing were demonstrated live during the afternoon; many additional samples were available on display. Probing questions could be asked of the originators; some of the discussions developed critical analysis of the contribution of the computing activity to learning by college students. Over 150 people attended the demonstrations during the afternoon.

An exhibit of books, reports and periodicals was available throughout the conference. Copy of the display bibliography and related materials may be obtained from Project EXTEND. A list of institutions providing displays

is included in Appendix B. Readers interested in particular topics mentioned should write the person indicated in case additional copies of materials on display may be available.

Many of the persons who came primarily for ICM 74 attended sessions of the Michigan Academy also. Symposia were attractive; some sessions included papers on computing. In future meetings of the Academy more presentations on research and instructional computing can be expected to appear throughout the various discipline sessions. A separate section of the Academy could be established to cover those aspects of instructional computing which apply across all disciplines. For example, it should be useful to get together panel sessions and workshops on various aspects of the technology and supporting services.

The evening sessions of the computing conference were scheduled for demonstrations and discussions. Ten telephone lines were available and all were busy throughout the evening. About 50 attendees examined anything from physics to sociology anywhere from Kalamazoo to Marquette. Some took advantage of the opportunity to work for extended periods of time at the terminals in specific discipline areas.

Saturday morning the demonstrations opened early and were active throughout the day. The Saturday technical sessions were the major substantive part of the program. The sessions on physical science and mathematics each attracted a substantial audience, about 50 in one and 40 in the other. Seven other sessions varied from 5 to 20 people; the total Saturday morning attendance was about 160.

Most of the afternoon workshop sessions derived from morning presentations. Mathematics presentations led to demonstrations of mathematical programs on the Dartmouth Time Sharing System, and to an extended look at the use of mathematical games in the remedial area. Papers from physical sciences resulted in two demonstrations on graphics and a workshop on computer-generated tests. Other topics included environmental games, simulated behavioral science experiments and social science data analysis.

The publication of this conference record is intended to be helpful to those who were not able to attend, and also to bring credit to those who made contributions to the conference through technical presentations, demonstrations and displays.

Mathematics Session Report

Herbert L. Dershem, Hope College, organizer and recorder

Over forty interested mathematicians attended this session and were treated to five excellent presentations on a wide range of topics. For further information on any of these topics, please contact the author of the paper directly.

The Contribution of Algorithmic Instruction to Conceptualization in Mathematics

N. T. Dinerstein, Kalamazoo College, Kalamazoo.

Dr. Dinerstein introduced the audience to the computer scientist's view of problem solving through a description of the top-down approach. This approach consists of beginning with the English language statement of the algorithm, replacing the English language statement with one or more English language statements and/or one or more flow-chart language statements, and continuing the process, each time choosing a remaining English language statement to break down. The process is complete when only flow-chart language statements remain.

The author's contention was that such an approach should be used in the teaching of mathematics. He argued that this approach would allow students to participate in the construction of algorithms and would teach them the basic methods of problem solving.

An example of the use of this method was presented based on a familiar algorithm from calculus.

A Computer-oriented Approach to Linear Algebra

John Van Iwaarden, Hope College, Holland.

Professor Van Iwaarden presented a new approach to the use of the computer as a teaching tool in a beginning course in linear algebra. The material presented was developed by Warren Stenberg and Robert Ducharme. The approach is implemented in a textbook written by these two men which is to appear soon.

The material of the course is unified by the introduction of one principal algorithm, called the Target Algorithm. From this one basic algorithm the student gains an understanding of the techniques

related to many of the problems of linear algebra including finding a basis, determining linear independence, finding the determinant, constructing the range and null space and constructing normal forms.

The most important aspect of this approach is that all techniques of the course are conceptually unified into one algorithm which can be implemented on a computer.

General Uses of Computing in Mathematics at Delta College
Robert DeVinney, Delta College, University Center.

A report was given on the unusual computing capabilities available at Delta College where there is unlimited access to the Dartmouth time-sharing system this year. A discussion followed of the advantages and disadvantages of such an arrangement with particular attention to the availability of the Dartmouth program library to assist in teaching mathematics.

Demonstrations of many of these programs from the Dartmouth library were given in the afternoon workshop.

Computer-generated Illustrations for Teaching Statistics
John T. Whittle, Hope College, Holland.

Professor Whittle gave a description of the ways in which he has used the computer in an introductory statistics course to motivate and assist students by means of computer-generated illustrations.

Applications of this idea to frequency distributions, the Central Limit Theorem, confidence intervals, testing hypotheses, and correlation and regression were given. Mr. Whittle felt that such an approach encourages the student to investigate on her/his own and to better understand the concepts involved.

Instructional Gaming for Remedial Learning in Mathematics
Layman Allen, University of Michigan.

In a time when colleges and universities are becoming more and more concerned about remedial education, it is important for faculty members to become aware of creative ways to deal with this area. One such approach was presented in this session by Dr. Allen.

The device presented to encourage learning was a game called EQUATIONS designed for use at the junior high school level. The game basically consists of constructing correct equations with each player taking a turn adding or removing possible components. The game is based on a challenge system where a player may challenge the

correctness of the preceding move. This game has been shown, by detailed studies, to significantly improve both the student's performance and interest in mathematics.

A further aid in the use of this game is the Instructional Math Play (IMP) Kit, a set of twenty-one lessons, each consisting of a different play of the EQUATIONS game. The student plays a carefully ordered sequence of these games against computer generated moves. A booklet for each game contains detailed tables showing all possible computer responses. Each lesson focuses on an important concept in mathematics, and there are five versions of each lesson. This allows the student who completes a game without encountering or understanding the key concept to repeat the lesson until she/he does. In this way, when the student has completed the twenty-one lessons, she/he should have a good grasp of the entire set of desired concepts.

Demonstration of the Uses of the Dartmouth Time-Sharing System for the Teaching of College Mathematics

Robert DeVinney, Delta College, University Center

A portable computer terminal was connected to Dartmouth College's time-sharing system (DTSS) by means of Delta College's direct line connection to the Hanover, New Hampshire campus.

Robert DeVinney from Delta College gave informal demonstrations of some mathematics programs which are available on DTSS. Of particular interest were the general graphing program which displays the graph of any specified function and a program called SIMPLEX which solves a linear programming problem.

In addition to the demonstrations, conference participants were given the opportunity to call up and use the programs listed in the Dartmouth program catalog.

Specific Dartmouth programs which are being used in mathematics courses at Delta College are listed below. Several of these were demonstrated at the ICM 74 conference.

Precalculus

1. GRAPH*** Plots the graph of a function. The X-axis is drawn in, and if X=0 in the given range, the Y-axis is also drawn in. User specifies the function in a 'DEF' statement and the minimum and maximum of the range, the spacing on the X-axis, and any undefined points in "DATA' statements.

2. PLOTDATA*** Plots a maximum of 100 data points on the same set of coordinate axes on the terminal. The co-ordinates are input, in any order, during the program run.

3. QUADROOT*** Computes roots, both imaginary and real, of any quadratic equation (an equation of the form A*X↑2 + B*X + C = 0) using the quadratic formula, given values for A, B, and C. This program includes both a subprogram and a driver program.

4. PERMUTE*** Generates all permutations of N objects.

5. BINOMC*** Computes binomial coefficients, that is, the number of ways N items can be divided with I items in each group.

6. SIMPLEX*** Uses a simple version of the Simplex method to solve small linear programming problems (limited to 60 activities, 30 constraints). The method is G. Hadley's two-phase method described in his "Linear Programming," pp. 149-158.

Calculus

1. GRAPH***

2. ROOTS*** Isolates and computes all real roots of the general nonlinear equation f(x) =0 in the domain of x from A to B (determined by the user). The roots are computed by Newton's method of approximation or by Mueller's scheme of successive bisection and inverse parabolic interpolation.

3. INTGRT*** Computes the integral of any function, over any interval, using Simpson's rule, a technique which breaks up a curve into pieces and approximates each section with a parabola.

Linear Algebra

1. INVERSE*** Inverts a matrix using the exchange method.

2. MATEQ*** Solves the matrix equation A*X=B for X in terms of the known matrices A and B, using the matrix inversion method. Allows for varying one or more elements of matrices A and B.

3. EIGEN*** Finds the Eigenvalues of an N by N matrix A by solving the N-th degree polynomial implied by the equation DET (A - X * I) = 0 where I is the identity matrix. The possible values of X are the Eigenvalues. The program may be time consuming for large matrices because of the number of matrix inversions.

A selection of biographical references concerning the Dartmouth Time-Sharing System are listed below.

Mather, Diane, and Len Smith, Catalog of DTSS Library Programs, Kiewit Computation Center, Hanover, New Hampshire, 03775, (1973).

This manual contains descriptions of and directions for accessing programs and files in the Dartmouth Time-Sharing System's public library.

Spencer, Donald D., A Guide to BASIC Programming: A Time-Sharing Language, Addison-Wesley, (1970).

An introductory text on the BASIC language and the use of a time-sharing terminal such as the Teletype, Model 33 ASR.

Waite, Stephen V.F., and Diane Mather, BASIC, Sixth Edition, University Press of New England, (1971).

This manual describes the programming language BASIC as currently implemented on the Dartmouth Time-Sharing System.

Simulation of Computer-Assisted Instruction for Remedial Learning in Mathematics

Layman E. Allen, University of Michigan, Ann Arbor.

A series of 105 IMP (Instructional Math Play) Kits has been developed to enable individuals to play the mathematical game EQUATIONS against a computer program designed to play as a good teacher would. These highly-branched kits (2500 to 3500 alternative pathways per kit) are in the form of 16-page pamphlets that can be used anywhere, freeing participants from the need for access to a computer terminal.

The kits were pilot tested on groups of junior high school teachers and students: posttest performance by both groups on problems involving ideas presented in the kits was about double what it was on pretests. Readers can gain some impression of the ideas involved and their level of difficulty by working through the problems below. The instructions to the tests and several sample items from one of them are included, along with suggested answers.

It will now be relatively easy to develop additional IMP Kits focusing on ideas that need special emphasis in remedial mathematics programs at the college level. The process for developing such kits is well specified, and a computer program is available to expedite their production. Some suggestions have already been received about topics that deserve such treatment (e.g., ratio and proportion, use of logarithm tables); other suggestions would be welcomed.

Additional auxiliary techniques in conjunction with the EQUATIONS game enable a teacher to focus attention on particular topics in mathematics. Some of these, such as the introduction of "adventurous rules" and the use of "box-cards", are also likely to be useful in remedial mathematics programs. For additional information on the use of any of these materials in such programs, contact: Layman E. Allen, Mental Health Research Institute, University of Michigan, Ann Arbor, Michigan 48104.

EXAMPLE

Instructions

By writing an X in the Yes or No column, indicate whether or not all of the numbers and operations in Column A can be appropriately ordered and grouped to construct an expression equal to the number listed in Column B.

If your answer is Yes, write that expression in Column C.

INSTRUCTIONS

	Column A	Column B		Column C	Yes	No
EXAMPLE A	+ x 2 3 4	14	=	2 x (4+3)	X	

Operations and numbers are grouped by inserting parentheses as in EXAMPLE A.

EXAMPLE B	* 2 3	9	=	3*2	X	

The * in Column A means "to the power of". Thus 3*2 indicates what is usually written as 3^2.

EXAMPLE C	√ 2 9	3	=	2√9	X	

The √ in Column A means "root of." For purposes of answers here indicate what root you mean by putting a number to the left of the √. Put a 2 if you mean square root; a 3 if you mean cube root, etc.

EXAMPLE D	+ x 2 4 6	11	=			X

There should be no entry in Column C when your answer is No.

	Column A	Column B		Column C	Yes	No
4.	* √ 6 6 7	7	=			
5.	+ * 1 2 9	3	=			
6.	* * 1 3 6	6	=			
7.	- - 1 3 5	7	=			
8.	+ + 1 2 4	8	=			
17.	- + 1 3 5	19	=			

Some Suggested Answers:

4. 6 √ 7 * 6 5. 9 * (1 + 2) 6. 6 * (1 * 3) 7. 3 - (1 - 5)
8. 2 + (1 + 4) 17. No

7

Computerized Help in Finding Logic Proofs

Arthur E. Falk, Philosophy Department, Western Michigan University, Kalamazoo

Western Michigan University has a program in operation which provides students with critical advice on proving inconsistencies in quantificational logic. The program adapts well to an extremely large range of student responses, which are typed in the notation of symbolic logic. Both in the competence of its advice and hourly cost it compares favorably with a human tutor in the capacity of critic.

QUINC (QUantificational INConsistency) is novel in that it not only demonstrates inconsistencies skillfully, but also helps students to do likewise by its constructive criticism of their attempts. Some advice they receive depends on a comparison of their work to the computer's proof. Thus it is one of the few CAI programs which make significant use of the calculative power of the computer.

The objectives of a one semester course in symbolic logic include the presentation of information about logical theory and its applications, development of the student's skills in translating ordinary discourse into schemata written in the notation of logic, and the development of her/his skills in demonstrating the inconsistencies in sets of inconsistent schemata. Classroom demonstrations with much student-teacher interaction and written homework assignments teach the latter skills. Both are economical compromises permitting the instructor to give some individualized attention to students while still maintaining a large number of student-hours of contact. However, class time spent doing many illustrative demonstrations prevents presentation of further applications of logic. By using QUINC to present illustrative demonstrations and guide the student's attempts, two weeks of class time can be saved for the presentation of additional applications of logic. The usefulness of the course to the students is thereby enhanced. Written assignments, tedious to correct in great detail, are not prescribed frequently enough. The value of the assignment is also lessened by the great delay between the completion of the student composition and the evaluation by the instructor. These particular deficiencies of written homework can be overcome if the student does the assignment on a teletype connected to a time-sharing system with a program like QUINC. The result is immediate and frequent advice tailored to her/his own response. The program supervises the student's work; comments on almost every response the student makes; and can offer more than sixty different pieces of advice on appropriate occasions.

QUINC remains useful to students even after they have mastered the procedures for demonstrating inconsistencies. These procedures become cumbersome when applied to more advanced problems, but with QUINC they can work out a proof quickly, leaving the tedious calculations to the computer. This permits much more extensive use of theorem proving in the exploration of axiom systems and formalized theories.

The program does not do many of the things we associate with CAI programs. For example, it does not choose or sequence the problems to be done by the student; that is left to the student or teacher. Nor does the program evaluate the over-all performance of the student. The teacher does this by administering tests and by examining printouts of each student's interaction with the computer. The program is not meant to put across new course content. We assume that the student has already learned the notation system, its interpretation, and the rules and stratagems for discovering inconsistencies. The program helps the student to organize what she/he has learned by bringing it to bear on problems in closely monitored practice sessions.

The program compares favorably with human advice-giving, both in cost and competence. It uses 19K of core of a PDP-10; on our system costs average $4.75 per hour of connect time per student. While this is higher than the cost of an instructor's demonstrating inconsistencies in class and correcting written homework, it is about the same as the prevailing rates for tutoring (in the sense of "assisting in remedial studies"). Although the program does give bad advice on occasion, it is competent enough to warrant comparison to a tutor, at least in the capacity as critic of student's responses. Seventy five students used the program for three weeks in their intermediate logic classes. At the beginning of this three week period they were given fifty inconsistencies, graded intuitively into five levels of difficulty. The students were told that in three weeks they must reach a level of competency at the fourth level of difficulty. The students then worked at the teletypes on as many of these problems as they felt necessary. No class time during this period was devoted to inconsistencies except for a very simple one illustrating three stratagems. No homework concerning demonstrations was corrected by the teacher during this period. Then the students were tested on a problem of level four difficulty. Depending on the particular problem used, between one-half and two-thirds of the students demonstrated the inconsistency without error. In the light of the instructor's past experience these results are more than satisfactory. The average student, however, was not quite as enthusiastic as the instructor. When the students were asked, "How helpful has the computer been in teaching you to prove inconsistencies?" they rated it at 2.5 (or C+) on a 5-point scale from 4 ("extremely helpful") to 0 ("no help at all"). Part of the problem was that they encountered annoying bugs in the program. Another part of the problem can be traced to the time-sharing system, for when asked, "How much of a hindrance has the waiting been for teletypes and computer connections, the delays in answers and garbled messages?" they also rated the hindrance due to the system at 2.5.

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A paper available from the author describes the sequence of events that occurs when the student interacts with the computer. A brief example follows:

	Interaction	Commentary
	.RUN DSK QUINC[63001,63000] HELLO. MY NAME IS HAL. SOMEDAY I HOPE TO BE A SPACE PILOT. IN THE MEANTIME I'M CONTENT TO HELP YOU WITH YOUR LOGIC. WHAT SHOULD I CALL YOU? MOLLY KLISMUSS HELLO, MOLLY.	The student calls for QUINC and is introduced to the computer.
a.	LAST TIME YOU DID SEVERAL LEVEL TWO PROBLEMS WITHOUT ANY MISTAKES. WHY NOT TRY SOME LEVEL THREE PROBLEMS TODAY? I'M READY TO HELP YOU TEST SOME SCHEMATA FOR INCONSISTENCY. THE DIRECTIONS FOR TYPING SCHEMATA ARE IN UNIT 60.	She receives a personal message from the instructor, based on examination of printouts of her previous work.
b.	($X)(Y)(FYX.-GYX) -(Z)($)FZW *	The student types the quantificational schemata she wishes to test for inconsistency.
c.	SCHEMA 2: THE EXISTENTIAL QUANTIFIER DOES NOT CONTAIN A VARIABLE. -(Z)($)FZW ↑ I CAN'T UNDERSTAND THAT, MOLLY, --"IT DOES NOT COMPUTE." HO HO HO AH, YES, MOLLY, WHY DON'T YOU NOW TYPE THE NUMBER OF THE INCORRECT LINE, RETURN, & I'LL TYPE "OK", THEN TYPE THE CORRECT VERSION. REPEAT THIS FOR OTHER INCORRECT LINES. WHEN YOU ARE DONE, RETURN, TYPE "*", AND RETURN.	The computer evaluates the schemata for proper construction. The student is told what error she has made and where it occurs. Nine different errors are diagnosed for the student.
d.	2 OK -(Z)($W)FZW * I'LL CHECK FOR PRENEX ORDER NOW, MOLLY. ($X)(Y)(FYX.-GYX) ↑↑↑↑↑ LINE 1 -- PRENEX	The student is then given the opportunity to correct her mistakes. If the schema is well-formed, the program checks it for prenex form.
e.	($Z)-($W)FZW ($Z)(W)-FZW ↑↑↑↑↑ LINE 2 -- PRENEX	The student then proceeds to do the proof.
	[Continuation not shown]	

Physical Sciences Session Report

John Moore, Eastern Michigan University, organizer
David Emerson, University of Michigan-Dearborn, recorder

The session was devoted to papers on the use of computers in science instruction.

Recent Advances in the Instructional Uses of Computers in Chemistry
Ronald W. Collins, Department of Chemistry, Eastern Michigan University.

The speaker outlined the present situation of computer use in chemistry education. There is no lack of suitable hardware; both graphics and portable terminals are commercially available. Software availability and transferability are more of a problem. While many different software designs exist, there can be major problems in moving them from one location to another.

Other problems exist in the area of pedagogy. Many chemical educators are not attuned to the idea of using the computers in these courses. There is not, for example, a general chemistry text integrated around computing, and many courses are not designed so that computing can be used. Exceptions are Keller Plan courses in which computer generated repeatable exams are almost a necessity. The speaker then examined present and emerging uses of the computer in chemistry.

Type of Usage Now	Frequency of Use	Shortcomings
Canned programs for data reduction	Often	Does not contribute to learning.
Canned programs for data simulation	Seldom	Ineffective without graphics, poor substitute for experiment.
Tutorial computer assisted instruction	Seldom	Great amount of programming time, low cost effectiveness, poor correlation with course objectives, poor site to site transferability, poor continuity of use.

Emerging Uses	Advantages
On-line classroom computation	Dynamic instructional use. Permits use of sophisticated mathematical methods during lectures.
Computer generated repeatable tests	Students learn from mistakes, correlates with course objectives. Relieves pressure of exams.
Semi-canned data reduction with complete instructor copy	Contributes to student learning without extensive calculation. Simplifies grading.

Collins concluded with a brief discussion of the activities of various organizations in this field. These include the Association for Computing Machinery (ACM); the National Academy of Sciences, National Research Council (non-funding); National Science Foundation, Office of Computing, CONDUIT Project, which is concerned with various disciplines, transportability and information exchange via workshops (funding); and Project COMPUTE, run by Dartmouth College, in which faculty members spend a summer at Dartmouth working on installation of computing materials.

Use of Computers for Data Processing in Physical Chemistry Experiments
Robert C. Taylor, Department of Chemistry, University of Michigan.

Four of the eight experiments performed in the physico-chemical measurements course employ computers. Computational assistance in the form of semi-canned programs is available in the laboratory for experiments in vapor pressure, binary boiling point diagram for benzene-ethanol, analysis of the vibrational spectrum of HCl and DCl, and the kinetic inversion of sucrose. The objectives are to give the student experience in using the computer and reducing the tedium of extended calculations. Small programmable computers are used and interfacing is being considered. Simulation has not been employed. This presentation stimulated vigorous discussion which centered around experimental details and techniques of curve fitting.

Implementation of CAI at EMU--Calalyst-PIL
Nina Contis, Department of Chemistry, Eastern Michigan University.

The objectives of the program are to provide interactive instruction and drill at terminals in stoichiometry, periodic properties, and aqueous equilibria. Ms. Contis demonstrated student-computer interaction via terminal. A discussion followed which brought out that the system has a HELP or HINT feature to suggest the solution to a problem if needed.

After two to four unsuccessful tries the answer is given. The lessons are designed to last twenty to thirty minutes per student and are voluntary because the number of terminals is limited. A year and a half was required to develop the system and although it has not yet been used extensively enough at EMU to permit a thorough evaluation, the results at the University of Pittsburgh are felt to have been good.

The LEARN Instructional System CAI
Garrett VanderLugt, Department of Physics, Western Michigan University.

The LEARN instructional language (LIL) written in MACRO-10 has the following characteristics: it is frame oriented like programmed instruction, it has mathematical capabilities, several answer evaluation modes, and branching capabilities to allow a student to move ahead more rapidly or to be instructed in more detail. The system also includes automatic record keeping (detailed or summary) including time, correct and incorrect answers. It stores raw answers so that a previous calculation is available during the lesson, and it has available functions and iterative procedures. Another feature is a coupler-slide projector interface which responds to characters to which the terminal does not. The system was demonstrated using a Newton's Law Calculation and a lesson on optics prepared by Joseph Loo. The lesson lists objectives, provides a summary of sign conventions and derivations if wanted, and presents problems, asks questions and evaluates responses.

Computer Graphics in Physics Instruction
John Herman, Department of Physics, Western Michigan University.

The on-line demonstration which Prof. Herman gave was the computation of eigenvalues for the one-dimensional Schoedinger equation by the particle in a box method or the inverted Gaussian method. The student guesses at an eigenvalue and, by regular changes, zeroes in on a solution. The system permits plotting the values and Lennard-Jones molecular potential calculation. Practice with single lens ray tracing with the use of a graphic cursor on a terminal is also possible. The use of graphics depends strongly on the quality of the telephone connection.

The Solar Wind Problem for Intermediate Mechanics Students
Noah Sherman, Department of Physics, University of Michigan, Ann Arbor.

Prof. Sherman stated his personal criteria for the use of computers in instruction: the problem should require a computer solution; the problem should be intrinsically interesting; and the problem should be a fresh one, i.e., it should yield some unexpected or fresh insights. The solar wind problem meets these criteria and two cases were discussed. The first dealt with a point mass in uniform clockwise circular motion around a central mass. The solar wind was then applied

in the (-x) direction and several plots showing the shapes of orbits resulting from different intensities of the wind. The second case was that of a body falling in a gravitational field and the effect of a solar wind applied normal to the original direction of fall in the (-x) direction at different wind intensities was calculated. The paths for several different wind intensities were shown; some of them were quite surprising. A program for this computation is available to those with access to the Michigan Terminal System.

Production of Audio-Visual Materials by Computer Graphics: Electron Dot Density Diagrams for Overhead Projection
John W. Moore, Department of Chemistry, Eastern Michigan University.

CALCOMP plotter capabilities used with suitable wave functions for atoms and molecules permit the plotting of electron dot density diagrams which then can be put in various colors on ozalids. These can be placed on top of each other on an overhead projector to produce images which illustrate the concept of electron density varying with distance from a nucleus. The electron dot density diagrams for the 1s and 2s orbitals of carbon, for example, clearly show the cross section of a nodal sphere, when superimposed. Two of the 2p orbitals were also shown. Another set of transparencies showed what happened to the electron density when lithium and hydrogen atoms were brought together.

Applications: Computation, Simulation, Data Manipulation within a Small College--Related to Research in Theoretical Chemistry?
Ralph Deal, Department of Chemistry, Kalamazoo College.

Work growing out of application of computers to problems in theoretical chemistry has lead to some teaching applications. In chemistry these include processing of laboratory data and non-laboratory simulation of problems in chemical kinetics and diffusion. The importance of analog computing was stressed. Some applications in courses for non-scientists were also mentioned. In the POLUT simulation, a class played the game of trying to control the dissolved oxygen in a body of water at 4ppm by knowing the temperature and controlling the treatment levels and plumping rate. In the EUTRO model of Meadows and Meadows technical advisors were assigned the task of preventing entrophication of a body of water by such strategies as the use of algicides and dredging. The speaker encouraged skilled computer users to cooperate with those in other disciplines who had interesting problems to solve.

The session was quite worthwhile and very well attended. One of the more valuable features was the opportunity to learn what others are doing in the field of educational computing in the physical sciences. Future meetings might include an informal session at which people not on the formal program could mention briefly the computer applications which might be of general interest.

Demonstration of Computer Graphics in Physics Instruction

John E. Herman, Western Michigan University, organizer and recorder

John Herman of the Western Michigan University Physics Department gave an on-line demonstration of computer graphics used in Physics instruction on the PDP-10 at WMU using a Tektronix 4010 terminal. The session was attended by 10 - 15 people throughout the afternoon and was organized very informally. Several FORTRAN programs were demonstrated. Among these were:

SEEV - allows students to solve Schroedinger's equation for one of several potential functions by successive guesses at the energy eigenvalue. The wave function and potential may be plotted for any energy guess.

ORBIT - Students may find and plot satellite orbits around the earth.

LENS - Using the graphic cursor input feature of the Tektronix 4010 terminal, a single lens may be defined and any number of rays traced through the lens from a defined object point. Especially useful for showing spherical abberation.

FPLOT - Function plotting program allows user to enter and plot any function of a single variable. Log, linear, or polar plots may be made.

DATPLT - Allows students to enter and plot experimental data.

All the graphics programs are capable of generating output suitable for plotting on a Hewlett-Packard graphic plotter. A number of examples of these plots were exhibited. Participants in the session were encouraged to try the programs "hands-on" and many did so.

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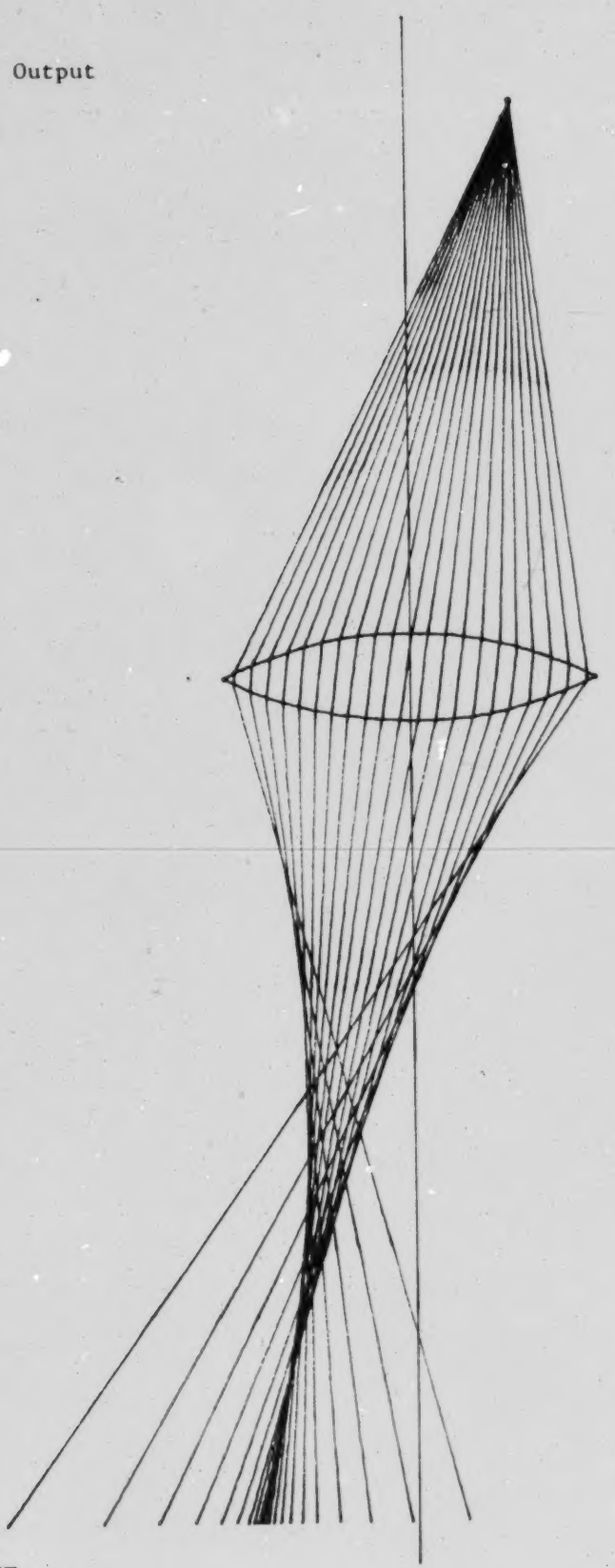
LENS Output



Computer Programs in the Teaching of Biology

Janice Glime, Michigan Technological University, Organizer

Dr. Janice Glime, Assistant Professor; George Funkey, graduate student; and Jerome Knutson, senior; of the Department of Biological Sciences of Michigan Technological University held demonstrations and discussions concerning biological computer programs. Participants were able to interact with the Michigan Tech Univac 1110.

Dr. Glime presented programs designed for teaching. The FOXRUN model enables a user to compare a donor and recipient control model and to manipulate a mountain stream ecosystem by changing standing crops or turnover rates. HARDY is a teaching program to teach the Hardy-Weinberg equations and how to use them. NATSEL simulates natural selection and allows the user to look at the effects of small and large selection factors through time. The print-out is on an exponential interval, enabling the user to quickly simulate many generations. MUT simulates the effects of various programs which compare EQUITABILITY values based on Brillouin's information theory vs. Shannon's information theory approximations. These values are compared to MacArthur's expected diversities and the equitability value of Lloyd and Ghelardi is calculated.

Jerry Knutson demonstrated population genetics and ecology programs. EXPOPS asks for a reproduction rate and an initial population size. It then prints out the size of the population every week for one year, by using the solution equation. EXPOPE does the same as EXPOPS, except it uses the Euler integration and the user can choose her/his own integration size. LGPOP graphs the Verhulst-Pearl population curve, using the integration size, initial populations, and reproductive capacity that the user types in. Two curves are plotted on the same graph, one is calculated using the solution method, the other using the Euler integration. LOTKA graphs the Lotka-Voltera interaction model, using the reproductive potential, carrying capacity, population size, and interaction effect that is typed for each population. SILSPR uses the original data of the Silver Springs model and types out the steady status and the standing crops of the state variables.

DRIFT is an instructional program. It first asks the user for a definition of genetic drift. It then checks the answer and types out VERY GOOD if the answer is right. If not, it asks if the user would like to try again. After the user has typed in the correct definition of genetic drift or has given up, it asks for population size, gene frequency, and number of generations. Next, by calling random numbers and checking these with the frequency, it simulates genetic drift. The program types out

every other generation, the new gene frequency, and the number of people with that trait. Since the random number generator is seeded with the time, the results change even if the same initial values are typed in.

JUNK gives the user random numbers with significant digits according to the user's specifications: repeating or non-repeating integers or real number, maximum value, number of random numbers desired.

COMPUKEY, another program demonstrated by George Funkey, was designed as an instructional tool to teach the basic concepts of use of any dichotomous key. Unlike many other computerized keys that suggest possible answers based on the user's current knowledge of the specimen, this version proceeds through any 28 question key sequentially, printing out one question per couplet. The user may reply to any question with any one of five answers: Yes, No, Maybe, Help or Change. A Yes or No directs program flow to the next appropriate question. Maybe is treated as a Yes answer but also "tags" the question as a difficult one. Help allows the user to access a dictionary of terms (presently 30 terms and definitions but easily expanded), obtain the definition, and continue with the current question. The Help answer also "tags" the question. The Change answer allows the user to Stop, Start all over, or return to any question in the key and continue.

The intended purpose of the key is to demonstrate to the student the correct way to key out a specimen. He cannot jump around in the key randomly (except with some difficulty) and is therefore forced through an orderly, logical process to identify his specimen. Hopefully, this will illustrate that identification of a biological organism is not an esoteric guessing game, but really a very logical process.

Since the key can be adapted to anything from red triangles and blue circles to umbilicate lichens (its present setting) it can be used for teaching and testing students in this important concept.

Extracts from two programs are illustrated on the following page.

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```
Student response follows double dash (--)

--QXQT EVOL. DRIFT
  WHAT IS GENETIC DRIFT?

--RANDOM CHANGE IN GENE FREQUENCY
  VERY GOOD
  GENETIC DRIFT IS A RANDOM CHANGE OF
  GENE FREQ.  ACCORDING TO EHRLICH &
  HOLM GENETIC DRIFT USUALLY DOES NOT
  OCCUR WITH A POP. SIZE OVER 500.
  HOWEVER, THIS IS NOT ALWAYS TRUE.
  ENTIRE FREQUENCY, POPULATION SIZE,
  NUMBER OF GENERATIONS
--5,100,25
  GENERATION NO., FREQUENCY NO. WITH TRAIT
       1              .470000          47
       3              .470000          47
       5              .350000          35
       7              .340000          34
       9              .410000          41
      11              .520000          52
      13              .540000          54
      15              .510000          51
      17              .620000          62
      19              .710000          71
      21              .710000          71
      23              .770000          77
      25              .800000          80
  WHAT WAS THE CHANGE IN GENE FREQ?

--.3
  THE CHANGE IN FREQUENCY IS .300000
  ENTER 1 TO RUN AGAIN, 2 TO STOP
```

The program searches for key words.

The program responds to whatever parameters the user puts in.

The user is invited to continue exploration

```
  FREQUENCY OF RECESSIVE GENE = .72, DOM. = .28
  WHAT IS THE FREQUENCY OF THE DOMINANT
  GENE (P)
  IF YOU DONT KNOW, TYPE .000

--.28

  WHAT IS THE FREQUENCY OF THE RECESSIVE GENE
  (Q), (Q=1-P)
  IF YOU DONT KNOW, TYPE .000

--.00

  P2 + 2PQ + Q2 = 1
  FREQUENCY OF THE DOMINANT PHENOTYPE =
  SQUARE OF P
  WHAT IS THE FREQUENCY OF HOMOZYGOUS
  DOMINANT INDIVIDUALS

--.09

  THE CORRECT VALUE OF P2 =  .078
  WHAT IS THE FREQUENCY OF HETEROZYGOUS
  DOMINANT INDIVIDUALS

--.42

  THE CORRECT VALUE OF 2PQ IS  .403
  IF THE POPULATION HAS 1000 INDIVIDUALS,
  HOW MANY WILL BE HOMOZYGOUS DOMINANT

--90

  YOU HAVE MADE AN ERROR, PLEASE CHECK
  HINT, MULTIPLY THE FREQUENCY (P2) BY 1000

  [Continuation not shown]
```

This is one of several problems available for practice of the Hardy Weinberg Equilibrium.

Environmental Systems and Games

R. C. Rosenberg, Department of Mechanical Engineering, Michigan State University, organizer and recorder

The session was organized with two principal objectives in mind. The first was to make available through presentations and on-line demonstrations a few existing games and simulations in their instructional contexts. The second objective was to begin the process of identifying people interested in the use of environmental games and simulations in support of instruction.

One presentation was made by Prof. Erik Goodman (Systems Science, MSU) on the development of quantitative, computer-based simulations by project teams of students, each team including some ecology (zoology, botany, etc.) and some systems science (computer science, engineering, etc.) majors. Some sample models were demonstrated.

A second presentation was made by Prof. Steve Harsh (Agricultural Economics, MSU) about an extensive set of Telplan programs accessible through touch-tone telephone. The programs included Income Tax Management, Least-Cost Swine Rations, and Beef Cow Planning Guide, among thirty listed.

Finally, Prof. Fred Fink (Engineering Instructional Services, MSU) described an undergraduate course, Introduction to Environmental Systems, which uses four on-line games to bring non-technical students into contact with quantitative models in a decision-making role. Two games discussed in some detail were DISPATCH (economic dispatching of electrical power) and WAQUAL (the effective treatment of sewage before it enters a river in order to preserve a required level of river water quality).

The second objective of the session was identification of interest in, experience with, and availability of material. In part, this process can be carried out by developing a public list of people; perhaps ON-LINE can serve such a function.

In addition to the session presenters mentioned above, the following people have indicated interest.

Janice M. Glime
Biology Department
Michigan Technological University

Karl Sjolander
Macomb County Community College

Ron Taylor
Lansing Community College

John A. Wenzel
Albion College

Mehran Thomson
Washtenaw Community College

Sister Constance Banks
Mercy College of Detroit

Neal Kilmer
E-325 Owen Hall
Michigan State University

Communication from readers expressing interest in offering material and information or soliciting such will determine whether or not we can develop an effective environmental simulation and games resource pool. If so, a panel session at ICM '75 might be organized to further the exchange of useful experience.

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The following extract is from the end of a simulated exercise in electrical energy dispatching called DISPATCH.

The input from the student is given after the double dash (--) following "COMMAND."

```
*******TIME 1600 HØURS

1. CØMMAND--LØAD
   EXPECTED LØAD FOR NEXT TIME PERIØD----6232.00
                                        MEGAWATTS

2. CØMMAND--ASSIGN
     GENERATØR ASSIGNMENTS
   GENERATØR NUMBER 1--1000
   GENERATØR NUMBER 2--1332
   GENERATØR NUMBER 3--1400
   GENERATØR NUMBER 4--2500
   PURCHASED PØWER-----0

3. CØMMAND--CØST
   TØTAL CØST INCURRED----------------------$ 18132.00
   CØST INCURRED IN PREVIØUS INTERVAL-------   5062.00

4. CØMMAND--GØ

   *******TIME 1700 HØURS

5. CØMMAND--LØAD
   EXPECTED LØAD FOR NEXT TIME PERIØD----6666.00
                                        MEGAWATTS

   CØMMAND--ASSIGN
     GENERATOR ASSIGNMENTS
   GENERATØR NUMBER 1--1000
   GENERATØR NUMBER 2--1466
   GENERATØR NUMBER 3--1800
   GENERATØR NUMBER 4--2400
   PURCHASED PØWER-----0

   CØMMAND--GØ

6. *******TIME 1800 HØURS

      -----STATISTICAL SUMMARY-----

   TØTAL MEGAWATT-HØURS GENERATED-----------$ 30605.00
   TØTAL CØST ØF PØWER GENERATED------------   32028.00
   AVERAGE MEGAWATT-HØURS/$ GENERATED-------        .96
   EXCESS PØWER GENERATED-------------------     375.00
   TØTAL LØAD REQUIREMENT (MEGAWATT-HØURS)--   30230.00
   NUMBER ØF BRØWN ØUT HØURS----------------          0
   NUMBER ØF PURCHASED PØWER HRS------------       0.00
   CØST ØF PURCHASED PØWER------------------       0.00
   GENERATØR PREFØRMANCE
     PWR-HRS        REPAIRS     FAILURES       HØURS
     4707.00          0           0            0.00
     5498.00          0           0            0.00
     8000.00          0           0            0.00
    12400.00          0           0            0.00
```

The user asks for the expected load, held constant for one hour.

The user assigns load to each of four generators, and does not buy any outside power.

Cost data are obtained.

"GO" signifies that the user is ready to try the power distribution for the next hour.

This user goes through one more cycle of load allocation.

At 1800 hours (6 pm) in this instance the program prints out a summary of the performance of the power system.

This user obtained a very good result for the first try; getting almost one megawatt-hour generated for each dollar of cost.

Other plays of the game might include maintenance requirements, failures, and repairs.

Demonstration of Computer Graphics in Science Teaching

John Forsyth, Michigan State University

On Friday afternoon, Friday evening and Saturday morning, interactive graphics demonstrations were presented by the Michigan State University Departments of Chemistry, Chemical Engineering, Civil Engineering, Computer Science, Geography and Mechanical Engineering. Hardware support for interactive graphics at Michigan State University consists of eight Tektronix 4010-1 storage tube interactive graphics terminals which are driven by the CDC 6500 time sharing operating system. Several departments and colleges have such units, which are located at various sites on the campus. An Imlac PDS-1 refresh terminal with an 8K miniprocessor is located in the Department of Computer Science. The Imlac can run either as a stand-alone device or as an interactive terminal for the CDC 6500. The teaching and research programs at Michigan State University make a variety of uses of this equipment.

Former students Bryan Drake and Richard Huntley designed and implemented Fortran software which drives the Imlac terminal from the CDC 6500. This software encodes all commands using the 63-character CDC 6500 display code instead of the usual full ASCII code. A comparison program (called CONVERSE) in the PDS-1 minicomputer converts the character stream to the appropriate set of display commands for the PDS-1 display processor. Mr. Drake also wrote a program which demonstrates numerical integration using either the trapegoidal rule or Simpson's rule. The user can select either the size of the approximation interval or the accuracy of the result as well as the integration method. Then the approximating functions are displayed so that the source of errors can be appreciated.

Another valuable teaching aid which uses the Imlac terminal is a program which aids in the design of reflux distillation columns. Mr Walter Anderson programmed this under the direction of Dr. Bruce Wilkinson of the Department of Chemical Engineering and Dr. John Forsyth and Mr. Richard Huntley of the Department of Computer Science. Mr. Kevin Wilkinson is currently writing a version which will use the Tektronix terminal. The lack of selective erase on the storage tube motivates a considerable redesign of the strategy for interaction.

In the Department of Geography, several studies of land use and resource management use storage tube terminals for interactive graphical data analysis. Dr. Robert Wittick and Dr. Gary Higgs have collected extensive data bases to support this work.

Several other projects currently in progress include:

On the CDC 6500 using the Tektronix terminal
- Airfoil design
- Electrical circuit analysis
- Scoring of musical compositions which will generate output which can be used as input to a computer music generation system
- A generalized two-dimensional drawing system written in Pascal
- Display of the history of development of a podgol soil profile
- Simulation of daphnia populations in water pollution studies
- Plotting and integrating of equations, numerical solutions of first order differential equations and curve fitting
- Plane truss analysis
- Diagrams of the vocal tract in articulatory phonetics

On the CDC 6500 using the Imlac as a terminal
- Driver software using full ADCII for communication
- Simulation of an electrical power system one-line diagram

On the Imlac PDS-1 as a stand-alone device
- Animated simulation of space craft docking
- Implementation of the game EQUATE, which teaches the construction of mathematical equations

There is also a package of software which performs generalized three-dimensional transformations. This is written in Fortran and Compass(assembly language) and creates data structures as designed by B. Herzog at the University of Michigan for his DRAWL language.

Computer-Generated Repeatable Tests in Chemistry

John Moore, Eastern Michigan University.

Between 15-20 participants attended the workshop on computer-generated tests conducted by John Moore, Eastern Michigan University, Jim Lubkin, Michigan State University, and Charles Falletta, Denison University. An explanation of the repeatable exams which were the basis for the workshop has been published in Computers in Chemistry and Instrumentation, vol. IV, (Marcel Dekker, Inc., 1974). An extract follows.

Computer-Generated Repeatable Tests in Chemistry

John W. Moore, Eastern Michigan University; Franklin Prosser, Indiana University; and Daniel B. Donovan, Corning West High School, New York.

Many college chemistry teachers are concerned about underachievement by students in their courses, poor attitudes toward learning and toward science on the part of underachievers, and the many anxieties which arise as a result of poor performance. More and more students avoid chemistry courses as much as possible not because of an innate aversion for the field but from a fear of performing poorly. A variety of proposals to alleviate such negativism have been made, but it is often difficult to see how to apply them appropriately within the usual university milieu.

One promising strategy for alleviating such problems is the mastery learning approach. This approach asserts that most students can achieve at a level near 80% of criterion for a given course provided that certain conditions having to do with proper specification of objectives, adequate evaluation and remediation, and sufficient allotment of time for mastery are met. Educational research indicates that such an approach produces favorable additudinal changes as well as increased achievement. Mastery learning evaluates students more on the basis of the time required for nearly complete mastery of a unit of instruction than the fraction of mastery achieved.

Despite the advantages of the mastery approach, especially for students of average or below-average aptitude, very few college and university instructors have adopted it. While this may be due in part to prejudice against or ignorance of educational theory, in many cases the tremendous logistical problem involved in applying a mastery

approach to large numbers of students is at fault. An obvious remedy is to use a computer to handle the large quantities of information involved. Two classes of computer usage may be defined on the basis of whether or not a student has access to on-line interaction with a computer.

The computer-generated repeatable test (CGRT) system which we will describe does not involve the on-line interaction of computer-assisted instruction (CAI) and thus is classified as one form of computer-managed or computer-facilitated instruction. It greatly reduces the logistical problems associated with mastery learning without involving its users in the high costs and specialized computer hardware of CAI. Many colleges and universities already have computing systems which can produce CGRTs. The option of adopting CGRT is open to a large number of individual instructors in a variety of disciplines.

General Description of the CGRT System

Large numbers of unique but equivalent tests are generated by a computer program which takes stratified random samples from an item pool and prints out questions and answers in a format appropriate to test-taking and machine- or hand-grading. Under this system students may be examined more frequently and encouraged to keep current. Students have a better opportunity for self-evaluation; they get immediate (within forty-five minutes) feedback since answer keys (including suggestions for remedial study) are provided as soon as the test is over. Most importantly, the exams, because they are unique, may be given repeatably. This allows the student to take a test, discover some of the performance objectives he had not thought of before, study or review to increase his mastery, and take the test again. These exams have real pedagogical value, and much of the trauma associated with testing large classes has been eliminated.

The Computer Generated Repeatable Testing process typically consists of four steps: 1) developing pools of test items, 2) producing tests, 3) administering the tests, and 4) scoring the tests. The second and fourth steps are managed by computer, while the execution of the first and third steps is strongly influenced by the computerized nature of the process.

For each exam, the course instructor develops a pool of items (test questions) which forms the data base from which tests are prepared. This is a rather formidable step. Our experience indicates that one should have at least six to ten items in the pool for each question on an exam to assure adequate variation of the individual tests. This work, although it has the advantage of being more familiar to most instructors than programming CAI, is every bit as tedious and time-consuming as it sounds. Fortunately, the item pools, once developed, are relatively permanent. Reusing test questions semester after semester, or even making the entire item pool available to students, is not a disadvantage under our procedure, and in fact is likely to be distinctly advantageous, since it is merely a specification of behavioral objectives.

Since items will ultimately appear on computer-generated tests, the form of the items must conform to the requirements of present computer printing technology. Normally, items may consist of upper-case letters, numbers and the usual special characters available on modern high-speed line printers. Diagrams, pictures, and other graphic aids cannot usually be printed directly, although the instructor may easily include these by providing the student with a supplementary sheet of diagrams to accompany the tests.

If the tests are to be graded manually, technology imposes no limitation on the structure of the answer of an item. If the instructor wishes to use mechanical grading techniques, he must provide for a single-character response for each item, because of restrictions imposed by the optical mark sense form readers usually available in universities. While this requirement may appear to be a severe limitation, it in fact allows considerable freedom in the form of objective test items. True-false and multiple choice items call for single character responses. Key-word, fill-in, and other forms resulting in a definite numeric or symbolic answer may easily be reduced to a single character response using the following convention: In such a question the form of the answer is indicated by a series of dots which includes one asterisk. The single character is indicated by the position of the asterisk in the string of dots.

In addition to the question part of an item, which the student sees when she/he takes a test, each item also has an answer part to allow machine-grading and to provide information to the student after testing.

The individualized tests are generated on a digital computer using a computer program GENERATOR. This program reads the item pool for a particular exam, checks the input data for proper sequencing and correct format, reads information describing the tests to be generated, generates and prints the individual test, and punches a small answer summary deck for use in mechanized grading. Each test is individually numbered and has questions on the left part of the line printer page and answers on the right. The instructor will of course separate the answer part from the question part prior to giving a test to the student.

The computer program selects items for a test by randomly choosing an item from each set. The order of choosing sets is also randomized. No item is used more than once per test. The time required to generate the tests is very small; the time required to print tests, however, is substantial. Nevertheless, the total cost per test is about five cents, which compares favorably with production of tests by conventional methods.

Scoring of the student responses for an exam is done by computer using program GRADER. Input to this program is the answer summary deck punched by program GENERATOR when the tests were prepared, and the student response cards derived from the mark sense forms. Output of this program is a roster of student IDs and test scores and a punch card deck of the high score for each student for this exam.

Computers have often been used as a tool to alleviate problems caused by the tremendous number of students enrolled in introductory courses at large universities. Most of these applications, however, have simply involved automation of teaching procedures which were already in common use. The computer-generated repeatable test system differs significantly from such approaches because it involves a mastery learning approach and is strongly student-oriented rather than subject matter oriented.

Performance objectives are specified by CGRT in the clearest form possible--as examination questions. Once objectives have been specified, CGRT allows a student to evaluate his understanding of subject matter and provides almost immediate feedback, including suggestions for remedial work and additional study. An additional advantage of CGRT and other mastery learning approaches is that a "curve" is no longer needed. An absolute scale of achievement is provided against which the student can match himself; grades become more a measure of how much time and effort a student is willing to spend to reach a given level of mastery than of what fraction of mastery has been reached by a given deadline.

Computerized Testing in Chemistry

Harry Eick, Michigan State University

Each year chemistry at Michigan State University is taught to 2,400 entering students whose backgrounds are very diverse. After reviewing the Chemistry program, the Freshman Chemistry Committee recommended that the department attempt to individualize offerings to each student. The rationale behind the decision was twofold. First, there seemed to be no reason why students who were interested in the biological areas of science should concentrate on a chemistry course designed to prepare a professional chemist. Furthermore, it is well recognized that students do not proceed at the same pace; therefore, a desirable program should allow for a different rate of progress for each individual student. With these thoughts in mind, Professor Hammer of the MSU Chemistry Department proposed a modularized type of freshman program in which the student proceeds at his own pace within certain constraints.

In this program each student receives a study guide which details what he should learn. Factual information is presented via audio cassette and hand-out sheets. Each student works at his own pace and takes an examination on the material when he understands the goals outlined on the study guide. The degree of mastery achieved by the student is measured through testing.

The syllabus of the course is divided into a series of topics, each topic roughly equivalent to one day's work. Examinations are given after every 7 or 8 topics and a midterm examination is also given to insure that the students obtain an overview of the subject. In contrast to the Keller Plan in which students demonstrate mastery, a grading scale is established for the course at the start of each term. If a student does not achieve the grade of expectation on an exam, he/she may repeat that exam within the time frame allowed by opening and closing dates.

In view of the estimated enrollment of 1200/term, it was mandatory that examinations be generated by computer to provide individualized testing. Consequently, a computer program was written for MTS to allow generation of examinations from a data base of questions.

In an effort to identify examination questions with relative ease, a simple labeling scheme was devised which includes a unit number, card number and question number. The unit number relates the questions to a given fragment of the course; the card number indicates a group of questions which in theory are quivalent; and the question number designates sequentially the question on the card. With this scheme it is possible to direct the computer to print an exam with each question specified uniquely, or to allow the program to choose at random questions from the data file within the constraints of the unit designators. The program is designed to prevent

a question from being reused until every question on that card has been used once. Interestingly enough, it is very easy to write numbers of questions on some topics, particularly problems, but it is sometimes quite difficult to write more than 1 or 2 questions for a definition.

To facilitate generation of multiple copies of the exam and its grading, the computer output includes not only the complete caption, e.g., a place for name and student number, a sequentially generated exam number, and the appropriate question numbers, but also the answers in a format permitting the answer to be cut off to yield a copy suitable for multilithing. Arbitrarily three types of answers are allowed: true-false, multiple choice, and completion.

In view of the multiplicity of the exams and the fact that the last exam taken and not the highest score is most important, a computer program was developed to keep records. The record keeping program is exceedingly versatile and contains a large repertoire of commands. The student name file is created from grades obtained from the Registrar's office and initially includes the student's name, number and college and classification designators. This latter information helps in statistical analyses of the course. Student names and student numbers may be entered into or deleted from the file, names may be changed, and spelling errors corrected. As expected, when an exam has been graded (currently by hand) a student operator attaches the appropriate student grade file, enters the command of the time and date the exam was given, the exam number and the student number and grade. When a student completes one examination and moves to a second, his record on the first is automatically closed and further entries cannot be made to it. At the end of each day, a listing of exam results by student number is generated on the line printer and posted. This list presents the grades of each student by examination and enables the student to compare his progress to that of the class as a whole.

If a student earns a grade of less than the failing score of 45, his records are automatically closed (CLOSED is printed in lieu of grades) and further entries will not be posted until a signed slip by a tutor is presented to the secretary in charge of records. The purpose of closing records is to insure not only that students in need of ehlp will receive that help, but also to discourage random guessing on exams. At the end of the term the student's record file can be generated in an alphabetical or a student number order, a section number order as requested by the Registrar, or in practically any format desired. Statistical analysis on grades are presented for approval and posting.

Since the students cannot see their performance records until the following day, they are normally required to copy their answers onto to an answer form which is subsequently graded, and to retain the question sheet. A corrected answer sheet is posted and those students who are interested may learn their results immediately. This special answer sheet is retained to verify that the student indeed took the exam and to clarify any questions which may result regarding the grading. Other options to the records keeping program are also available. It can be arranged to accommodate a laboratory course with any assignment of scores given to

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each experiment, a lecture-recitation course which includes quizzes and exams, or a comparable course which includes quizzes, exams and homework. Any type of weighting can be given to the various entries and as indicated, a grade report and statistical analysis of the grades are available immediately after the last entry has been made.

The computer-generated testing program has been operating successfully for two years at Michigan State University. In addition to the obvious benefits to the student, the record keeping program allows considerably more statistical analysis and has reduced substantially the number of record keeping errors.

SAMPLE EXAM POSTING

STUDENT	EXAM 1	EXAM 2	EXAM 3	EXAM 8	MEAN
386456	93				93 4.0
668646	80	87			80 3.0
504439	73 100	80			100 4.0
504731	87	87			87 3.5
516803	60 67	80			67 2.0
543167	93				93 4.0
562945	87	73 73			87 3.5
592556	100				100 4.0
600735					0 0.0
622532					0 0.0
622829	80				80 3.0

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NAME _____ STUDENT NUMBER _____

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EXAM 1- 10
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1. The charges on the electron and neutron are not equal but they have the same electrical sign. [t] [f] [t] [X]

2. The compound Na_2S is named
   a. sodium sulfide
   b. sodium sulfate
   c. sodium sulfite
   d. sodium sulfone
   [a] [b] [c] [d] [X] [b] [c] [d]

3. A 27 gram sample of oxygen difluoride, OF_2, contains how many molecules? (Atomic weights: O = 16, F = 19; Avogadro's number = 6.0×10^{23})
   a. 3.0×10^{23}
   b. 6.0×10^{23}
   c. 6.0×10^{23} divided by 4
   d. 2 times 6.0×10^{23}
   [a] [b] [c] [d] [X] [b] [c] [d]

4. A box of salt (NaCl) weighs 1 lb. Approximately how many moles of salt does this box contain? (Atomic weights: Na = 23, Cl = 35.5; 1 lb = 450 grams)
   a. 26000
   b. 0.02
   c. 0.1
   d. 60
   e. 8
   [a] [b] [c] [d] [e] [a] [b] [c] [d] [X]

5. At standard temperature and pressure, how would the volume occupied by one mole each of diatomic chlorine and monatomic xenon compare? (Atomic numbers: Cl = 17, Xe = 54)
   a. The chlorine volume is greater than that of xenon
   b. The chlorine volume is equal to that of xenon
   c. The chlorine volume is less than that of xenon
   [a] [b] [c] [a] [X] [c]

6. The sum of the oxidation states of all the atoms in a neutral molecule must equal zero. [t] [f] [X] [f]

EXPER SIM: Experimental Simulator in Behavioral Sciences

Dana B. Main, University of Michigan, organizer and recorder

About twelve persons from different colleges in Michigan attended the EXPER SIM Workshop. Dr. Dana Main gave the presentation describing EXPER SIM, how it is used in the classroom, and how the programs are organized. Some of the programs were demonstrated on the computer terminal in the morning session. There were descriptions of the different models in the library available and some selected models were discussed.

A Simulation Writer program is being prepared which enables college instructors or advanced students to develop and place their own data-generating models into the library. Transportability was discussed, and the Summer Institute on computer data-generating models was announced. This Institute will be held August 12-23 at the University of Michigan and directed by Dr. Dana Main. Its purpose is to familiarize participants with the simulation writer and encourage the development of their own data-generating models. The funding program sponsored by the Exxon Education Foundation (called Project IMPACT) was also described. Further details about EXPER SIM were described in the January issue of ON-LINE; reprints are available from Project EXTEND.

In the afternoon participants were encouraged to try the different programs on the terminal. There were about a half dozen people at any one time during the afternoon session; several came in and stayed the entire time; others were in-and-out. The different models were demonstrated and different features of the Supervisor program were emphasized.

EXPER SIM (Experimental Simulation) is a system for teaching research design through computer simulation. It includes not only a set of computer programs and accompanying written materials for student and faculty use, but a classroom pedagogy that can emphasize the learning of research strategies in the context of a simulated scientific community.

EXPER SIM is appropriate for any undergraduate course concerned with asking research questions and analyzing empirical results from experiments designed to address those research questions. Although the system has been piloted and originally developed within a behavioral science context, its applicability to biological and physical science as well as political science can be seen. It has been developed for the student and instructor who are naive in the use of computers and who do not know how to program.

MODE 1: EXPERIMENTAL DESIGN

In the first mode, the student receives a description of a particular problem area. This description may be very brief and may include references to the real literature. It may be more or less extensive in supplying students with informational detail. It usually describes conflicting theories. It is meant to set the stage.

The student also receives a complete list of all possible manipulable variables and their allowable values defined by the data-generating model. In the simplest case, she/he is informed of a single dependent variable and its values. There may be more than one dependent variable described. The student is further informed of the value of each manipulable variable that is defaulted if she/he chooses to ignore it. The default value may be constant--that is, a particular value of the variable. It may be selected from the set of possible values by some random process.

Formulation

In this mode, a student designs an experiment by specifying 1) the number of experimental groups in the design, 2) for each group, the values of the manipulable variables and the names of the dependent variables in the case of more than one dependent variable, and 3) the number of subjects (within a specified range) for each group. (It is also possible for a model to contain the capability of repeated measures. If so, then the number of measures on a subject can be specified.)

Results

This information is submitted to the computer and serves as commands to a data-generating model. The student's output are values of the specified dependent variable(s) which can be plausibly interpreted as raw data. All of our data-generating models have been probabilistic; therefore, the very same design generates different values of the dependent variable.

Depending on the research goal the student generates hypotheses, designs experiments, summarizes results, and explores relationships between manipulable variables as well as functional relationships among different dependent variables. The student is encouraged to report her/his findings in terms of support or disconfirmation of possible theories. She/he gets into problems of scaling and is motivated to acquire some statistical skills in order to make inferences about the underlying model generating the data.

MODE 2: HYPOTHESIS GENERATION

In the second mode, the student again receives a description of a problem area. But this time she/he is informed of only a subset of the manipulable variables and of all, some, or none of their possible values. The student may also be informed of only a subset of possible dependent variables utilized by the data-generating model. She/he is made aware, either initially or later, of one or more X-variables which may be

contributing effect to the results. The concept of X-variables in instructional simulations was first suggested to us by Richard Johnson in 1972 and was developed for classroom use by Cromer and Thurmond at the University of Louisville (reported in the Proceedings of the 1972 Conference on Computers in Undergraduate Curricula). In Cromer and Thurmond's instructional models the student is provided with a complete set of variables, less one: the X- variable. Information gained from runs on the other variables may or may not lead the student to infer the X-variable. If she/he does, the instructor provides a computer command that causes the X-variable to contribute to the values in the data in subsequent runs. If the student has not correctly inferred the appropriate variable, but some other implausible or impossible alternative, the instructor may give a command that makes no systematic contributions to subsequent data values.

AVAILABLE COMPUTER PROGRAMS

1. A library of data-generating models are available. Those in the library at present are as follows: 1) Etiology of Schizophrenia by David Malin, 2) Imprinting by D. W. Rajecki, 3) Motivation in Routine Tasks by Susan Mueller, 4) Drugs and Learning by Howard Eichenbaum, Trudy Villars, and Richard Nussloch, 5) Social Facilitation by D. W. Rajecki. (Accompanying each of these models are written materials for student use and, in most cases, additional instructor materials.) The computer data-generating models are Fortran subroutines.

2. The Michigan Experiment Simulation Supervisor by Robert Stout is a large (20,000 word) Fortran IV program designed as an interface between students and the data-generating models. It is simple to use, requiring little special knowledge and skill from either the student, instructor or the simulation designer, yet it is a flexible, powerful system. For example, a student can specify an experiment involving a five-way factorial design with only five lines of input to EXPER SIM. Students can design factorial experiments involving complete or incomplete designs, balanced or unbalanced designs, or even split-plot (within subjects) designs or covariance designs. There is no general type of experimental design it is not possible to do. At the same time, it can handle virtually any kind of model that a model builder may design by preparing a data check for the supervisor which interfaces the supervisor to the model written as a Fortran subroutine.

An interactive program that enables an instructor (or advanced student) to place a model into the library, without the necessity of a programmer or knowledge of programming, is being developed and scheduled for completion by April 30 at the latest. It is being designed to handle a wide spectrum of possible models that do not necessarily make assumptions of linearity and independence. Markov process options will be available as well as a library containing random number generators for a variety of univariate and multivariate distributions.

Which program one might use depends on local needs and computer facilities. The first two programs provide suitable models for student use in the classrooms as they are now. Even a rather small computer can take these data-generating models. If the subject content of the models in the present library is inappropriate, local staff can develop their own models. The Supervisor program is important if a new model is to be used by students with ease.

Behavior Science Instruction Laboratory

Melvin Katz, Computer Institute for Social Science Research, Michigan State University, organizor
Anne Nieberding, Computer Institute for Social Science Research, Michigan State University, recorder

Plans for a Behavior Science Instructional Laboratory which will be implemented at Michigan State University during the 1974-75 academic year were presented at the Conference on Instructional Computing in Michigan. The goals of the Laboratory are two-fold:

1. To introduce undergraduates to modern computer technology.

2. To provide undergraduates with the opportunity and tools to conduct meaningful experiments using actual research data.

To achieve these goals the students will be introduced to the research experience via computer-aided instructional modules. These modules will be designed to introduce the behavioral science student to the various research designs. Each module will include a section of text and some questions to insure the student comprehends the material. The student will conclude by doing a research project appropriate to the material. This gradual intermixing of text and numerical analysis hopefully will reduce the often noted anxiety level of behavioral science students when they are first introduced to mathematical concepts.

Research projects will be handled through use of RESEARCH and EXPER SIM. RESEARCH is CISSR's adaptation of the University of Michigan's VOTER program. It is designed to analyze aggregate and survey research data. RESEARCH is relatively inexpensive to run as it compresses the data into bits and stores data in an inversed matrix form. It is appropriate for the Laboratory aims as it 1) accepts English language commands and 2) possesses advanced data filtering capabilities.

EXPER SIM, which was developed by Dr. Dana Main of the University of Michigan and presented by her at the workshop on Saturday morning, performs an analogous role to RESEARCH for experimental research. (For additional information see the report on Dr. Main's workshop.)

After the student is introduced to research design and is capable of analyzing data, a natural outgrowth of the system is to encourage the student to use her/his tools in substantive courses. The laboratory will provide the space and consultants for students doing behavioral science term-papers and for students taking independent study courses.

CISSR hopes eventually to establish three laboratories, each in a different building on the Michigan State campus. Each center could serve approximately 400 students per week assuming that the centers are open an average of forty hours per week with the average student utilization being one hour per week.

Each center will contain five interactive terminals with silent thermal printers, which are well suited to a laboratory situation. Additional work space will be provided in the laboratory so that the students may organize their materials before sitting down at the terminal.

A graduate assistant will be available in the Laboratory to answer questions and to aid those having difficulties with the theory, programs, or consoles.

During the 1974-75 academic year, a single laboratory center will be established. The funding for the prototype laboratory center is being provided through the university under the Ford Foundation Venture Fund.

Some of the text and question management will be handled through the PLANIT system. PLANIT is a computer-aided instruction language developed by the Control Data Corporation and implemented at Michigan State University under the supervision of Dr. Morteza Rahimi. Using the computer as a textbook allows the flexibility of branching to different sections of the lesson depending on the needs of the individual student. Thus, a student could skip material she/he knows already and concentrate on areas of difficulty. This textbook will instruct the student in the use of the laboratory and the particular project that she/he will use. Also, it will review pertinent concepts such as sampling, use of control variable, and research design which were covered in class. Since PLANIT keeps student records, it also could be used to administer individualized tests and keep scores.

After students have learned proper research techniques through the use of EXPER SIM or RESEARCH, they should be ready to conduct their own experiments or surveys. Since they have been exposed to computers in the BSIL, the students should be less fearful of using computers in their own work. They can take advantage of canned statistical routines in the CISSR2, STAT, SPSS and other packages to analyze their data. Most of these routines have free-form control cards and can be used via teletype. Thus, students can make use of the BSIL faculties for their own work.

Behavioral science courses should include a large number of exercises to reinforce the learning experience. However, keeping records of scores on all these exercises is quite time consuming. To reduce such tasks, instructors can use a computer program called GRADER, which was developed by the Computer Institute for Social Science Research at MSU. GRADER can store up to 16 scores per student. It can compute t-scores for each score and the weighted total for either the raw or the t-scores.

GRADER allows scores to be dropped and it can print histograms and frequency distributions for individual tests and for the weighted total. Percentile rank is also computed. Grades can be assigned if cutoff scores for the weighted total are provided. With GRADER, it is possible to correct information without re-entering all the scores. Often, it is convenient to submit a job via teletype to correct student names, student numbers, and scores.

In conclusion, the Behavioral Science Instructional Laboratory will aid the student in grasping the often confusing and anxiety producing techniques of scientific investigation. Also, the BSIL becomes a teaching assistant for the instructor by reviewing and applying techniques she/he has covered in class and by easing her/his course-related administrative work.

The Inter-University Consortium for Political Research

Stewart Robinowitz, University of Michigan, organizer

The data files and statistical programs of the Inter-university Consortium for Political Research were demonstrated and discussed. Information about a summer training program for computers in undergraduate teaching in social research was available.

The Inter-university Consortium for Political Research was created in 1962 as a new development in academic organization. It is committed to the several objectives of an inter-disciplinary, inter-university research and training facility for the social sciences. These objectives include: 1) maintain archives of machine-readable social and political data that will serve a variety of research and training needs; 2) conduct training programs in research design and methods of quantitative analysis as applied to social inquiry; and 3) develop and distribute computer-based systems of social data management and statistical analysis which offer a wide range of opportunities of maximizing the use of the archives.

To achieve these objectives the ICPR is organized as a partnership between the Center for Political Studies of The University of Michigan and some 190 universities, colleges, and non-profit research organizations in the United States and abroad. Through close cooperation with member institutions and other organizations such as the European Consortium for Political Research, the International Social Science Council, UNESCO, and other social data archives, the ICPR has facilitated a wide range of international cooperative activities among social scientists. The guiding premise of the ICPR is to maximize the availability and utilization of social scientific resources and to minimize the inconvenience and cost of teaching and studying socio-political phenomena. The membership structure has proved to be an equitable and efficient means for serving these ends.

Data collected and organized by the ICPR serve a variety of purposes. They constitute source materials for specialized collections maintained by member institutions, they are used directly in both faculty and student research, and they are widely used in both graduate and undergraduate teaching. The ICPR staff provides a full range of data processing services including special computations and data processing for members with limited access to data processing facilities. The level of use of the data has mounted steadily since the founding of ICPR.

Initially, ICPR archival holdings centered around the major election studies of the Michigan Survey Research Center and a few early quantitative studies done elsewhere. As the lists of the Survey Research Archive holdings in the following sections indicate, a much broader substantive collection is now available. Moreover, additional resources of data were added with the development of the Historical Archive. More recently, major developments have taken place in the field of international relations.

ICPR sponsors a summer training program designed to encourage the diffusion of basic methodological and technical training to member institutions while offering unique work through its own constantly changing courses. Intensive inter-disciplinary work for historians, political scientists, sociologists, and other social scientists is provided through a set of eight-week courses. Experiences in data processing and the analysis of data in individual or small group projects complement formal lectures and discussions in most of the courses. In addition to core work in methodology and research techniques, the summer program often includes one or two research conferences for senior research scholars.

Faculty research, student theses, curricular revision, and the growth of local data archives and data processing facilities are increasingly supported by the ICPR. These activities are carried out as the staff strives to eliminate the variety of technical barriers inhibiting research and teaching.

A major activity here is the provision of an integrated package of computer programs (OSIRIS) to an increasing portion of the members. This greatly aids their access to their local computing power. It facilitates the transferral of the summer training experience to their campus. It expands the efficiency with which the archival resources can be employed.

Staff members of the ICPR presented an overview of the ICPR organization and activities, with examples of documentation and other materials. The remainder of the time the staff was available for informal questions from interested individuals.

Arts and Music Session Report

David Wessel, Michigan State University, organizer

A demonstration of computer-generated art and music was given live and with an opportunity for participants to interact with the programs and procedures. The session was held in a comfortable room recently dedicated in the Computer Center especially for work in the arts related to computing. A permenent exhibit of computer-generated art hangs on the walls and the room is equiped with high quality audio equipment for playback of a composer's effects with the computer as his aid and instrument. A four-channel, computer-synthesized composition by John Chowning was very impressive, and the attendees also heard a practice tape from a session in which Chowning was exploring directional effects for a new composition.

A presentation on computer-assisted design was given by Joseph J. Kuszai, of the MSU Department of Art, with comment by James R. Burnett from Computer Science. A number of works and many interesting techniques were displayed. For example, a process for transforming a line drawing of one object into another, with successive steps superimposed with slight displacement giving the appearance of abstract strobe photos, was shown to have considerable artistic merit.

Computers and instructional innovations in music were discussed by David Wessel and Mark Dionne, both of the Department of Psychology, MSU and John Clough, from the School of Music at the University of Michigan.

COMPUTING IN THE COMMUNITY COLLEGES

Edward Erskine, Macomb County Community College, organizer

The session was designed to 1) investigate the widely diverse present patterns that Michigan community colleges are using in computerization of management and planning activities, programs to prepare students for computer-oriented occupations, and the use of computers in the teaching-learning process; and 2) to analyze the strengths and weaknesses of these patterns for delivering computer support in all three areas.

Over 25 attendees representing 14 colleges (Alpena, Ferris State, West Shore, Central Michigan, Concordia, Jackson, Oakland, Macomb, Delta, Oakland University, Kalamazoo, Findlay, St. Clair and Lansing) began by defining five specific objectives that each participant would attempt to achieve during the session:

1. To better understand the present utilization of computers in the state's community colleges.

2. To gain one "better idea" in computer use that could be useful at the home school.

3. To contribute one good suggestion to the group for improving instructional computer systems or applications.

4. To analyze the pros and cons of alternative patterns.

5. To decide whether a continuing dialog among state community colleges in the area of computer utilization may be fruitful, and if "yes," what is the most effective way to maintain this dialog?

Brief presentations by representatives of various community colleges described their present systems, achievements, problems, unmet needs, and plans for the future.

Oaklands's IBM 360/50 is heavily committed to management and student records applications. The computer supports Oakland's unique program of mapping students' cognitive styles and on-line registration. A book catalog of library and audio-visual materials at all four campuses is computer-generated. Students in data processing are the only users of computers in instruction; Oakland plans to expand instructional applications, move more applications on-line and to offer an apprenticeship to students in data processing.

One reporter inferred that the involvement of the computer in instructional applications is directly proportional to the enthusiasm of the data processing director. Certainly this is evident at Muskegon where instruction is the number one priority. Students have hands-on use of all data center equipment for 15 hours weekly. Students in data processing programs have increased two-fold in two years. Present applications include test scoring, item analysis and computer augmented accounting courses. Courses in FORTRAN and programming principles for other curriculums are being introduced next Fall. Under the present director, Archie Hall, the data center operation has increased from 75 hours to 302 hours monthly. Part of the center's cost is recovered by selling services to the local public schools. Present resources are taxed to capacity and the major concern is financing expanded services.

West Shore exemplifies the determination of small schools to get computer access on tight budgets. Instruction and management are now supported by Mason County Public School's computer center. West Shore, Mid-Michigan and Ferris State are exploring a consortium approach, hopefully with a federal subsidy.

Macomb secures management data processing in-house using an IBM 1401. Several timesharing vendors and the Macomb Intermediate School District supply on-line and batch-processing support for instruction. Over 700 students are enrolled in data processing at the South Campus; another fifty take courses in numerically controlled drafting and machining. Eleven teletypewriter terminals at both campuses provide student access to FORTRAN and BASIC. Macomb is about to purchase a fourth generation computer which will replace much reliance upon outside sources and permit a quantum expansion of computer applications.

Data processing priorities at St. Clair County Community College are: 1) data processing curriculum, primarily batch mode; 2) administrative uses including on-line registration; and 3) other instructional use, primarily in timesharing mode. Six terminals are available for student and faculty use, which is heaviest in biology and accounting. St. Clair also sells computer services to local businesses.

Delta has about a 60/40 ratio of adminstrative to instructional computer applications. Faculty were introduced to computers through a Project EXTEND seminar. A study, Computers in Teaching and Learning Applications (CITALA), resulted in Delta's affiliation with the Dartmouth instructional system. Over 300 student and teacher uses are logged-in monthly through six terminals. They have effectively conducted computer-related, in-service programs for their faculty.

Alpena's data processing department provides administrative applications for the parent K-12 school district. Administrative applications account for approximately 85% of the computer's usage. All uses of the computer are in the batch mode with the following priorities: 1) administrative; 2) instructional; 3) data processing curriculum; and 4)

faculty research. There are many similarities between this system and the Oakland system including cognitive style mapping and a student information system. One major concern is to generate instructional use of computers by those instructors in the fine arts area.

In addition to the typical administrative and data processing curriculum application at Kalamazoo, their computer is used to support mathematics courses, industrial production careers, and drafting. The primary concern is how to stimulate faculty to incorporate the computer into their instruction.

The session ended on a very positive note with the group generally satisfied that we had met our objectives and agreeing that further dialog between community colleges in the state would be beneficial if we forget about each other's hardware and concentrate upon similar applications and instructional goals.

Contributions of Computing to College Teaching and Learning Activities

Karl Zinn, organizer and recorder

The session on contributions of computing to learning and teaching was attended by about 45 people. A collection of reference materials including a glossary, a statement of domain and trends, and an overview of computing were discussed and led to a discussion on effective computer use and the implications of computers for education and society. The resource materials used in this session are available for the workshop organizer, Karl Zinn, at the Project EXTEND office in Ann Arbor. Three selected topics not included in the EXTEND documentation are discussed below.

1) Faculty resources for effective use of computing in education

Any discussion of effective use of computing in college teaching must give careful attention to faculty incentives, professional development and participation in decision making. Faculty dedication to quality instruction is a resource that can not be purchased; faculty time committed to materials development is an investment to be encouraged.

Incentives. A major consideration in enhancement of educational computing is "What incentives do the faculty members have to do something innovative and of high quality and perhaps of lower cost?" Assignment of faculty time to review curriculum materials or develop new materials locally (being released from some other duties) is important for some persons but it is only part of the answer. A critical review of curriculum material and software under consideration for local adoption does take much time. Development of material specifically for local use is even more demanding, and in some cases it would require more time than can be justified by local use. In general, the preparation of a program and related materials costs far more per hour of instruction than can be justified by the number of students served at the author's institution. Programs and curriculum materials need to be borrowed from other places; and those persons who are successful as local authors should be encouraged to share programs and materials with others, in some cases receiving royalty payments or other remuneration. The Coast Community College District (Orange County, California) provides one good model.

For some faculty members the most important incentive for improved computer use at this time is professional support. One kind of support by chairmen and deans will show at time of consideration for promotion or other academic rewards. A more immediate reward should be evident in the organization of personal resources for innovative teaching activities.

Programming or other technical assistance should be available for materials development projects. Tutors or other aides should be assigned to help students explore new computing resources. Chairmen and other administrators should be planning for professional support within department budgets.

A third incentive (or resource) for faculty is technical services and equipment. Faculty should be informed about funds for "innovative travel" and encouraged to use them to explore potential computer uses and enhancements. Another way one should be able to contact colleagues using computing at other institutions is by telephone and remote terminal connections. Assistance for audiovisual production and manuscript duplication should be publicized.

Access to computing is for many persons the most important incentive for improving computer use, and therefore should be included among means for developing the faculty resource. Convenient computing should be available and it should be made visible. Some designs of computer terminals encourage effective use. Portability can be an important factor since access should be extended into the classrooms and laboratories, into seminar meetings and faculty offices, and sometimes into homes. The computer system reflects good access in communication capability, storage capacity, and user-oriented software.

Professional development. A graduate seminar on instructional computing in college teaching should be available to faculty on a convenient schedule. The success of such a seminar offering shows in the report of Project CITALA from Delta College, University Center, Michigan (ON-LINE, November 1973).

Conference and workshop activity should be encouraged on campus or nearby. Faculty members learn from presentations by others, and also from assembling a report of one's own experience to share with others.

A collection of examples of potentially effective computer use should be maintained in a visible way. As many as possible should be kept on the computing system, and user guides and instances of use should be presented in an attractive and useable format. Each description in such a demonstration package should include some statement of rationale for computer use and some indication of costs and returns.

A library of resource materials should be conveniently located for faculty use. The office of a faculty member who wants to spend time with interested persons is sufficient for a beginning; eventually the collection should move to a shelf in the learning resources center or other central location, with some materials duplicated in department offices. Annotations should be entered on a bibliography of the collection, and perhaps taped in the front of each book as guidance for users. For example, some otherwise useful references are out of date in some parts. In order to keep the library current, responsibility for subscriptions and recurrent conference proceedings should be clearly identified.

Participtation in decision making. Faculty resources for effective educational computing can be enhanced by faculty participation in decision making. Faculty participation on an advisory committee extends the base of ideas and concerns which shape the policy regarding computing resources. Faculty representatives to a policy making body can serve as spokesmen to the faculty as a whole. Decisions about computing resources at the level of departments, programs and courses should involve the faculty members concerned. Departments with much computing activity may find a separate committee on educational computing can make a substantial contribution to planning and utilization. In any case, faculty members should be involved in allocation of computing resources for teaching, at least as much as they are in the purchase of new books for the library, or equipment for the laboratories. Awareness of costs and alternatives tends to stimulate more effective uses of what is available.

2) Sources of programs, related materials and ideas outside a college

Because of the importance of software and curriculum materials in an otherwise "empty" machine, and the cost of development of quality materials, sources outside a college are crucial to enhancement of computer use.

Special projects for development of curriculum or sharing of materials are perhaps the best source. Funding from the National Science Foundation, the National Endowment for the Humanities, the National Institutes of Health, Exxon Education Foundation, the Sloan Foundation or other such sources commits an individual or development team to share; sensible projects have budgeted the costs of exporting materials. One list of projects was assembled for Project CLUE (1970) and another for the Project EXTEND Sourcebook (1973). Special attention should be given to the Physics Computer Development Project at the University of California, Irvine, the Computing and Mathematics Development Project at the University of Denver, the TICCIT System of MITRE Corporation and Brigham Young University (remedial math and English), and various curriculum projects using the PLATO System (physics, chemistry, computer science, etc.).

Consortia and networks may be helpful, even without direct participation of the College. For example, Project EXTEND is sharing computer programs and resource materials with institutions outside the reach of the MERIT Network. CONDUIT is moving toward a national clearinghouse function, at least with respect to review in selected discipline areas. Northwestern University has been given "associate membership" in CONDUIT (previously limited to five regional computing centers) especially for development of CAI exchange. These and other regional groups are listed in the EXTEND Sourcebook.

Nearby institutions are an important source of ideas and perhaps mutual support. Short distances and a variety of occasions for informal meetings contribute to the sharing of ideas. Common geographical interests (e.g., state support for higher education!) encourage exchange at this level.

Professional association committees and publications are a very influential source of ideas, and should convey some affirmation of programs and materials (e.g., favorable reviews or certification of programs). However, most national organizations have been slow to move in the area of computer-related instruction. In the meantime an annual Conference on Computers in the Undergraduate Curricula is providing a place for presentation and discussion of reports on computer use in various disciplines. Professional associations concerned with college teaching should take on this function with improved quality and wider influence. A list of discipline-oriented sources is given in the Project CLUE Report; some of the areas noted for valued contributions are physics (programs, monographs, and program review), chemistry (national program exchange), geography (monographs and program exchange), social research (data bases and training institutes), and medical sciences (program distribution).

Commercial publishers have been holding back; the market for computer-related publications is not clear, and publishers are pressed financially to proceed with more sure ventures. Commerical distribution systems are effective, and in time they will take over many functions of collection, review and dissemination. Project COMPUTe at Dartmouth College, with funds from the National Science Foundation, is encouraging writers of books and monographs which extend the use of computer programs and procedures, and helping to find publishers. Some of the publishers to watch are Houghton-Mifflin, McGraw-Hill and Entelek.

Vendors and their users groups have not been a significant factor in educational uses until recently. DECUS, the user group for Digital Equipment Corporation, led the way with a newsletter and program distribution service; its effectiveness depended very much on the enthusiasm (and camaraderie) of mini-computer users. Digital has since taken over the educational users group function, distributing a newsletter (EDU) and programs (for example the Huntington Project materials). Hewlett-Packard has also done much to serve the field of educational use (and build a market), perhaps surpassing Digital in size and depth of its newsletter (HP Users Group Newsletter) and collection of computer programs and related user guides, monographs and textbooks. Although primarily directed at high school users, both newsletters and program libraries are worth having, even without having equipment of those particular vendors.

3) Considerations of cost and effectiveness

Questions of cost and effectiveness are not easily settled in regard to what appear to be essential academic resources. In what ways does an individual student benefit from the library resources of a college? What is his share of the cost? What is the cost of essential science laboratories when distributed among all students in a college? Various reports from national committees and review projects have proposed figures for computing expenditures per FTE student per year, or per student enrolled in courses using computing. The inescapable conclusion is that computing is an essential part of learning resources for higher education, and a crucial component of preparation for some professions.

Most of the decisions to use computing will be made on substantive grounds: computers may be the subject of instruction, an essential tool of the trade, or an important resource for learning. For some computer uses there exist clear options for delivery of instruction, testing, management of records, etc. The trade-offs may concern clerical costs versus computing costs (to achieve the same technical assistance), and tutorial costs versus computing costs (to maintain enrollments). Cost savings will be obtained, in relation to other means for achieving the same goals, where (1) a freedom to explore, test and revise leads to new materials and procedures, and (2) a willingness to examine critically and compare sorts out the computer uses which are superior to non-computer alternatives. With expanding enrollments and budgets some monies should be marked for computer assistance; with a fixed budget computing resources will be in competition with other equipment and with clerical and paraprofessional assistance. Decreasing costs of computing offer hope of expanding this resource for learning in spite of fixed budgets.

In a field of rapidly changing technology combined with growing sophistication of users it is important to keep many options open. All users should find convenient access through both batch stations and interactive terminals; educated users will exploit the best of both, sometimes shifting work back and forth depending on the stage of program development and problem solution. Teachers should try to maintain non-computer alternatives for computer-based learning exercises; some students may work better without computer assistance, and the non-computer alternate sets a base line for costs and convenience. The academic computing service should provide a variety of programming languages and software packages; different subject areas and learning objectives have different needs, and programs which might be borrowed from other institutions will come in a variety of languages.

Although exploration and new ideas need to be protected, operational uses of computing in instruction should be subject to critical review. What contribution does computing make in contrast with alternatives? What are the relative costs? What do the students think of the computer's role? How well do they perform? Faculty members and academic computing staff need to have time to analyze potential applications and to review them carefully after trial use.

A major consideration in determining the most effective uses of computing is the curriculum reorganization and automatic information processing which lead to tenfold increases in learning and performance. Students in areas such as engineering, architecture, music and medical technology are able to perform at a much higher level with computer assistance than without, and learn information related skills with greater scope and detail. Using appropriate computing resources, a college will better prepare its students for these vocations. Limited resources usually are better spent on computing as a tool for practice of complex skills than as a medium for presenting drill or assisting with management of instruction.

Although computing can be used to achieve orders of magnitude improvement in learning and performance, one should not overlook the contribution of five or ten percent in selected situations. For example, in remedial math or English the computing assistance may make the difference between survival and failure for many students. This small but significant assistance may keep performance above the threshold for frustration and discouragement which leads to dropping out. Failure results in a loss to society as well as to a college.

Discussion of costs and effectiveness must include consideration of the near imperative of some computing for all students and much computing for some. Although computers are not as central as libraries to the educational enterprise, they may soon be added to the guidelines for accreditation.

To provide a quality education, both in professional and general programs, and to attract students, a college must provide academic computing. Institutions in Michigan are making good progress as can be seen in the various sections of the program for ICM 74: mathematics, physics, chemistry, biology, environmental science, engineering, psychology, political science, sociology, history, philosophy, graphic arts, and music.

Planning Terminals and Communications Facilities for Academic Computing

LeRoy H. Botten, Andrews University

A survey of participants (about 30) in the Terminals and Communications session indicated a wide variation in background knowledge and experience. In order to meet the needs of the greatest number of participants, emphasis was placed on a tutorial presentation.

Major emphasis was placed on describing various equipment functions and costs, and on communications jargon. The philosophy and methods of the communications study done at Andrews University was presented. One point which seemed to excite particular interest was the experience Andrews University has had with leased twisted pairs as a means of providing very inexpensive ($0.85/month per circuit) communications channels.

The regular session adjourned at noon. An informal discussion of individual communications and computer selection problems was continued over lunch (and until about 3:00 p.m.) with approximately 10 participants.

Since the organizer agreed to conduct the workshop less than two weeks prior to the meeting, the paper used as a basis for the session was furnished in partial draft form. The paper is intended to complement "Methods Used in a Recent Computer Selection Study" (delivered at ICM 73) and describe extension of the philosophy and methods of that mainframe selection study to a terminal and communications system. The paper, when completed, will be available upon request to the author (LeRoy H. Botten; Director, Computing Center; Andrews University; Berrien Springs, Mi 49104).

Almost 300 copies of "Methods Used in a Recent Computer Selection Study" have been distributed (most since ICM 73). It would seem, therefore, that a healthy interest exists among many computer users in doing a detailed mainframe selection study. Although a terminal and communications study seems formidable, it is possible to provide good facilities at a reasonable cost. As in a mainframe selection study, however, asking the right questions is essential in meeting these goals. As a follow-up to this ICM 74 mini-workshop, copies of the paper will be made available upon request to the author.

Introduction to Communications Planning for an Educational Computing System*

This paper is meant to serve as a fairly non-technical introduction to the planning and procurement of communications facilities associated with a digital computer. To a limited extent it also documents a communications selection study conducted at Andrews University during 1973. This study closely followed the methodology and philosophy of an exhaustive mainframe selection study which was completed early in 1973. The mainframe study itself is fully documented in "Report of Computer Selection Study Committee (1973)." A summary and critique of the mainframe study methodology is available in "Methods Used in a Recent Computer Selection Study (1973)." This paper should be considered to be a continuation of the methodology paper into the communication realm.

The communications procurement process can be divided into three phases: feasibility study, hardware selection study, and acquisition study. The feasibility study includes identifying required applications, establishing criteria and desirable features, drafting a request for proposal, and only then making vendor contacts. The hardware selection study includes coordinating data gathering (including proposals), designing a proposal rating scheme, completing proposal ratings, and making tentative hardware selection. The acquisition study includes evaluating subjective factors, (e.g., stability of vendor, stability of product line, overall evaluation of software, user reaction, etc.); reviewing standard contracts; reviewing cost factors, conversion and interfacing costs, installation and site preparation costs, staffing and training costs, and various other costs; establishing desired non-standard contractural clauses; and only then entering final contract negotiations.

Benefits of Interactive Processing Versus Cost

Interactive programming development can increase programmer productivity significantly. Certain applications (graphics, data acquisition, etc.) are implemented much more easily in an interactive mode than in a batch mode. The quick response to a user's request for interactive service (seconds) is much more acceptable than the usual batch turnaround time (hours or even days). It is usually much easier for those unfamiliar with computing to learn to use a system via an interactive terminal than via the batch mode. The capability of accessing the computer from remote locations such as classrooms and laboratories may be very useful. As a problem solving tool as well as an instructional tool the computer is much enhanced by adequate timesharing and remote batch capabilities. Similar advantages exist for administrative applications.

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*From a partial draft paper by LeRoy H. Botten, Andrews University, March 22, 1974.

Although there is a strong trend to move toward timesharing and remote batch operations, such a move is not without its problems. The cost of procedural design, computer and peripheral hardware, interface and communication hardware, and terminals may be a prohibitive factor. The major goal of the communications selection study is to identify the minimum cost solution to the above problems which permits required uses and reasonable possibilities for growth as required. This is often a rather complex task.

Other factors may also influence the desirability of accessing a computer via remote devices. Useability, that is, the versatility and convenience, of a system or terminals must be carefully evaluated. (Contrary to sales claims of some vendors, there are few computer systems in the medium price range which deliver really good timesharing services.) Security of confidential or vital files must be considered. (Various systems differ widely in security provisions.) Glamour must never sway estimates of real utility. (Remote processing is often useful, but it is never cheap.) Remote processing systems bring forth a whole new family of management problems (like planning communications facilities?).

Devices and Communications Facilities

A brief description of the devices and communications facilities which are part of a communications system follows.

The Computer System

Most computers currently being marketed offer at least some data communications capability. Three basic classes of services exist: timesharing, batch and remote batch. Timesharing is characterized as a dialogue between man and machine. Batch work implies submission of work "over the counter" with results to be picked up at a later time. Remote batch implies submission of programs and data via communications facilities with results also returned via communications facilities. Be very careful not to confuse "timesharing" and "remote batch entry" (also known as "remote job entry" or "RJE").

If communications equipment is to be added to an existing computer system, planning difficulties may be eased since certain alternatives may be fixed by the system. If a new computer system is being contemplated, consideration of communications capabilities should be given as part of the mainframe selection process. The following questions should be given special attention:

1. How well does the operating system handle timesharing, remote batch, and batch operation concurrently? ("Real-time" operation has been omitted.)

2. Does the system support the EIA RS-232 standard interface? (Most systems do support RS-232.)

3. Does the system support a variety of line disciplines, transmission codes, and transmission rates?

4. What constraints exist concerning execution in a particular mode (e.g., batch) of a program created in another mode (e.g., timesharing - for which program creation is particularly efficient)? (Some of the best known systems hamstring users in this area.)

5. Can all language processors be used via communication facilities? (Again, it is surprising that some of the best known systems offer only limited timesharing capabilities.)

6. Can the system support preprocessor equipment if the communications load requires such support?

Terminal Devices

Terminal devices are available in a wide range of capabilities and costs. Five major categories emerge:

1. Typewriter-like ("hardcopy") terminals such as the familiar Teletype series or those based on the IBM Selectric mechanism;

2. Cathode ray tube (CRT) terminals which, on casual observation, are similar to television sets with a keyboard;

3. Programmable ("smart") terminals contain internal circuitry which permit local computing as well as communications with a remote computer system; and

4. Remote batch (RBT) terminals which may include a rather full set of peripherals. In fact, it is not uncommon for a small computer system to be used as a remote batch "terminal" to access a larger system.

5. Special purpose terminals include portable terminals, touch-tone terminals (which might be used by a salesman at any phone booth to enter orders, etc., into a central computer), audio response terminals (good voice synthesizers are now in use), and mark sense units.

Typewriter terminals are available in a wide variety of types including impact printers (e.g., Teletypes), non-impact printers (e.g., thermal printers), and a few less common types. Terminals of this type commonly operate at maximum speeds of 10 to 30 characters per second (100 to 300 words per minute; nominally 100 to 300 bits per second). Special keyboards and printer characters are also available for some units. A few hardcopy terminals include provisions for graphics. Although speed

is very low in relation to computer calculation speeds, they are satisfactory for routine timesharing use. Prices range from about $800 for a Teletype terminal to $5,000 or more for a more capable unit.

Cathode ray tube terminals are quiet, usually capable of faster operation than hardcopy terminals (up to 9600 bits per second when under computer control), often less expensive and more reliable than otherwise similar hardcopy units, and of course produce no paper output. In the present environment of high paper cost and shortages, the CRT is a help. For computer aided instruction the CRT is ideal. In some applications, however, hardcopy is required. Consideration should be given to using a mixture of CRT and hardcopy terminals in terminal "clusters" to serve academic needs. Many special features are available. Prices range from $1,200 to over $8,000 depending on capabilities required.

Intelligent terminals began to emerge in the 1960's following the introduction of integrated circuits. Although economy of scale is a very important consideration (i.e., a larger system if well utilized can usually do a given job at less cost than a smaller system), the problems of writing operating systems which will handle multiprogramming and also control many independent communications lines may lead to software problems which offset economy of scale. Intelligent terminals may be used to edit data and reduce communications traffic or to perform some calculations locally. Use of such "distributed processing," by reducing central system communications overhead, may help improve overall system response. Costs for intelligent terminals start at about $3,000.

Remote batch terminals differ from the above terminals in method of data transmission. Most typewriter-like terminals and CRT terminals transmit and receive data character-by-character using asynchronous transmission. The RBT usually transmits large blocks of data synchronously. Transmission speed is usually 100 to 600 characters per second on the public dialed network and 120 to 960 characters per second on leased lines. Synchronous transmission requires fewer bits per transmitted character than asynchronous transmission, but requires more hardware logic and is more expensive. The typical RBT includes a punched card reader, a control console, and a printer. Other configurations are possible and magnetic tape, disk, or diskette storage may be included as well. The RBT may be programmable and, as previously mentioned, a small computer is sometimes used as an RBT to access a larger system while performing small scale calculations on-site. The cost of an RBT usually exceeds $10,000 and must be balanced against savings in personnel and communication line charges.

Common Carriers and Tariffs

Terminal devices and computers have been discussed as they relate to remote processing. The next step is to look at how information is transmitted from a terminal device at a remote site to a centralized computing facility.

The companies providing such services are called "common carriers." The communications common carriers fall into three groups: the public telephone system, Western Union, and specialized common carriers. The telephone system includes a great diversity of companies, although only one company is authorized to serve a given geographical area. Services available from the telephone companies include: direct distance dialing (DDD), WATS, Telpack, point-to-point leased lines, Datrex, Datacom, Dataphone 50, TWX, and others. Western Union offers a broad range of data transmission services. In the last few years several common carriers, including the Bell System, have proposed systems dedicated to just digital data transmission. Microwave links and satellite links have been proposed for these services.

Services of various types are provided by common carriers at rates and under conditions specified by tariffs. Tariffs are approved by governmental regulatory bodies (Federal Communications Commission for interstate tariffs; various state or local agencies for intrastate tariffs) and form a contract between the user and the common carrier.

Modems, Datasets, Couplers, and Limited Distance Adapters

Modems, limited distance adapters (LDA's), Data sets (Bell System modems), and couplers are all used for essentially the same purpose. One such unit must be available at each end of the common carrier channel. Each performs modulation and demodulation functions to enable digital transmissions to be made over the telephone system.

Couplers are devices which act as modems but which also easily interface to any standard telephone. Most couplers use acoustic coupling (some use magnetic coupling) to transmit and receive signals from any telephone handset. Couplers have made possible truly portable terminals.

Many terminal vendors are now offering modems (standard or as an option) which are integral with the terminal. This is economical since the terminal power supply and case also suffice for the modem.

Multiplexors and Concentrators

Multiplexors permit two or more low speed channels to be combined for transmission on a single higher speed channel. Using multiplexors to avoid long runs of parallel (or nearly parallel) physical telephone circuits may often yield a net saving even considering the cost of the multiplexors. The major disadvantage in such a plan is that if the single higher speed circuit or either multiplexor unit should malfunction, all channels are usually lost.

The term "concentrator" has two common definitions. The first usage is equivalent to "multiplexor." The second usage (and the one used hereafter) is the accomodation of more terminals than there are multiplexed channels. The multiplexor is usually implemented by means of a frequency-division (FDM) scheme while the concentrator is usually implemented by means of a time-division (TDM) scheme.

Communications Front-ends

Multiprogramming makes possible multiple independent computing tasks. Since the transfer of usage of system resources is controlled by and "at the pleasure of" the operating system, such transitions normally occur smoothly. Timesharing and remote batch operation serving many sites requires a computing system to respond to and control many independent communications channels. The problem is that each line is independent and the computer operating system (or communications handler) is expected to respond "at the pleasure of" each user device. Most systems, even very large systems, do not handle this task especially well. Recently as the cost of mini-computers has dropped, a trend has developed to use distributed processing in the form of a preprocessor to relieve the central computer. In many cases this can dramatically improve total system response. It is assumed that "front-end" implies a programmable computer with its own memory.

The communications front-end can perform many useful functions:

1. Line control (including polling, auto-answer, dial-up, and acknowledgement);

2. Character and message assembly (including serial-parallel and parallel-serial conversion, assembly and disassembly of messages, and handling start-stop bits or synchronizing characters);

3. Data conversion (including automatic code sensing and conversion);

4. Data and message editing (including reformating of data by removal of spaces, unnecessary text, etc., and other compression; or other data restructuring);

5. Error control (detection and correction of transmission errors before reaching the host system); and

6. Message buffering and queueing (re ves a great deal of overhead from host system).

Demonstration of the MERIT Computer Network

Susan Colman, MERIT Network, organizer

A demonstration was presented by Ms. Susan Colman, User Consultant for the MERIT Computer Network. She demonstrated a graphics teaching tool for users of the MERIT Network. This graphics demonstration provides the user with an introduction to the network by way of geographic structure and system structure displays. Further displays show simulated instruction streams of common network procedures, with simulation of expected system responses, both in the instruction stream and graphically.

The MERIT Computer Network interconnects the computers of the three major universities in the State of Michigan: a CDC 6500 at Michigan State University, an IBM 360/67 at the University of Michigan, and another IBM 360/ 67 at Wayne State University.

The network itself is rather like a "mode of transportation" of information from one computer to another. The information transportation is made possible by the use of three communications computers, or CC's interfaced to each university's computer (host computer). These CC's are DEC PDP-11s.

A major objective of the MERIT Network is resource sharing among the three hosts. A unique resource on one host computer will draw users of another host computer to it by means of the network.

Further information concerning the MERIT Network may be obtained from Ms. Colman at the MERIT Network central office, 1037 North University Building, Ann Arbor, Michigan 48104. Telephone: (313) 7649423.

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Appendix B: Institutions Providing Displays

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University of Michigan
Wayne State University
Western Michigan University

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Joseph Rogers, Great Lakes Colleges Association
Ronald Rosenberg, Michigan State University (Engineering)
David Wessel, Michigan State University, (Psychology and Computer Music Project)
Karl Zinn, University of Michigan (MICIS)

Local Arrangements Committee

Gerald St. Amand:	Housing and Transportation
Melvin Katz:	Demonstrations and Displays
Charles Wrigley:	Accomodations and Services
Karl Zinn:	Publicity and Proceedings

Supporting Organizations

Association of Independent Colleges and Universities of Michigan
Great Lakes Colleges Association
Michigan Community College Association
Michigan Council of State College Presidents
Michigan Interuniversity Committee on Information Systems
Michigan State University Computing Laboratory
Southeastern Michigan Community College Instructional Administrators
University of Michigan Center for Research on Learning and Teaching

News Items

CREATIVE COMPUTING: Computers Can Be Fun!

Creative Computing is a lively new magazine reflecting the view that computers can make learning fun! It contains games, simulations, problems, exercises, curriculum materials, and ideas directly usable in classrooms in colleges, junior colleges, secondary schools, and even elementary grades.

The new magazine deals with the use of computers and computer related devices in mathematics, science, social science, ecology, computer familiarization, computer science, and career education. It is a forum for the discussion of the social impact of the computer with a focus on privacy, automation and jobs, leisure time, medical care, pollution control and the like.

Creative Computing also provides evaluative reviews of computer hardware, software, applications material, learning aids, books, games, and related devices. Contributors report on successful experiences in instructional computing, thus providing a vehicle for the interchange of programs and materials. Readers will find capsule summaries of significant educational and computer conferences and meetings.

Published bi-monthly, the primary objective of the magazine is to bring high quality, useful information to students and educators at a reasonable cost. Try it for a year! You'll like it!

- David H. Ahl, Editor
Creative Computing

Editorial Note: Creative Computing also needs additional contributors and reviewers. If you have a favorite classroom technique, a new and different program, an unpublished curriculum guide, a computer game or simulation, or a better way to use existing material, please write! Potential contributors and subscribers should address inquiries to:

CREATIVE COMPUTING
P.O. Box 1036
Concord, Massachusetts 01742

Conference Calendar

Date, Place	Theme, Sponsor, Contact
August 12-23 Ann Arbor, Michigan	Summer Institute on Instructional Computer Modeling. Chrysler Center, Ann Arbor. Sponsored by University of Michigan. Contact: Dana B. Main, Mason Hall, University of Michigan, Ann Arbor, MI 48104.
August 13-15 Bellingham, Washington	Summer Meeting of the Association for Development of Computer-based Instructional Systems (ADCIS). Contact: Ronald Christopher, Ohio State University, 1080 Carmack Road, Columbus, OH 43210.
August 18-22 Snowmass, Colorado	5th Annual Seminar for Directors of Academic Computing Services. Contact: E.R. Krueger, University of Colorado Computing Center, Boulder, CO 80302.
October 14-16 San Diego, California	Computer-Assisted Test Construction Conference. Royal Inn at the Wharf, San Diego. Sponsored by San Diego University, ETS and IBM. Contact: Gerald Lippey, IBM, Monterey & Cottle Roads, San Jose, CA 95114.
October 16-18 Toronto, Ontario	Administrative and Instructional Computing in Postsecondary Education. Inn on the Park Hotel, Toronto. Sponsored by EDUCOM. Contact: Carolyn Landis, EDUCOM, P.O. Box 364, Rosedale Road, Princeton, NJ. Phone: (609) 921-7575.
November 11-13 San Diego, California	ACM 74. Convention Center, San Diego. Sponsored by Association for Computing Machinery. Contact: Lyn Swan, P.O. Box 9366, San Diego, CA 92109.

This calendar carries notice of conferences and other activities dealing with computers and education, particularly in or near Michigan or otherwise of special interest. Many interesting and worthwhile activities at Michigan institutions are not scheduled enough in advance for notice to be carried in this calendar. Interested readers should arrange to receive the local newsletter or other communications from computing centers at nearby institutions.

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